सत्यमेव जयते

Medical Officer's Manual for Implementation of Malaria Control (NVBDCP)

Regional Office for Health & FW, Bangalore
Directorate of Health & FW Services, Karnataka

राष्ट्रीय वेक्टर जनित रोग नियंत्रण कार्यक्रम
NVBDCP

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PREFACE

The "Medical Officer's Manual for Implementation of Malaria Control Programme" has been developed for use by medical officers of the Primary Health Centers, Community Health Centers and general hospitals of the state.

The guidelines in the manual are based on the operational manual published by the Directorate of NVBDCP Delhi and circular instructions time to time.

The Medical Officer is the head of the health team at the Primary Health Center. He is expected to lead the team in organizing the prevention and control of malaria and other vector borne diseases. The objective of this manual is to convey to the medical officer the details of various activities concerning planning, implementation and monitoring of malaria control in his primary health center area. He may use the information to guide / supervise the activities of the PHC laboratory and field work of the health workers. The manual describes the job responsibilities of medical officer, basic aspects of epidemiology of malaria, individual case management, malaria control strategies, and recording /reporting.

In light of the malaria elimination goal, the medical officer has the responsibility to organize proper malaria control activities in the area under his jurisdiction.

The guidelines given in the manual are not exclusive, but they are a starting point and stimulus for action in various areas crucial to malaria control. They must continue to evolve locally, through action, adaptation, experimentation and periodic evaluation. The reference materials in terms of individual guidelines for each area of operations are mentioned at the end of the document.

I acknowledge the help rendered by Sri Sudarshan, Sri Jegatheesh and Sri Prakash in preparation of the various chapters in the book.

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1 EPIDEMIOLOGY OF MALARIA

1.1: MORPHOLOGY, LIFECYCLE AND TRANSMISSION OF MALARIAL PARASITE

Life Cycle of the Malarial Parasite:
The malarial parasite undergoes 2 cycles of development – the human cycle (asexual cycle) and the mosquito cycle (sexual cycle). Man is the intermediate host and mosquito the definitive host.

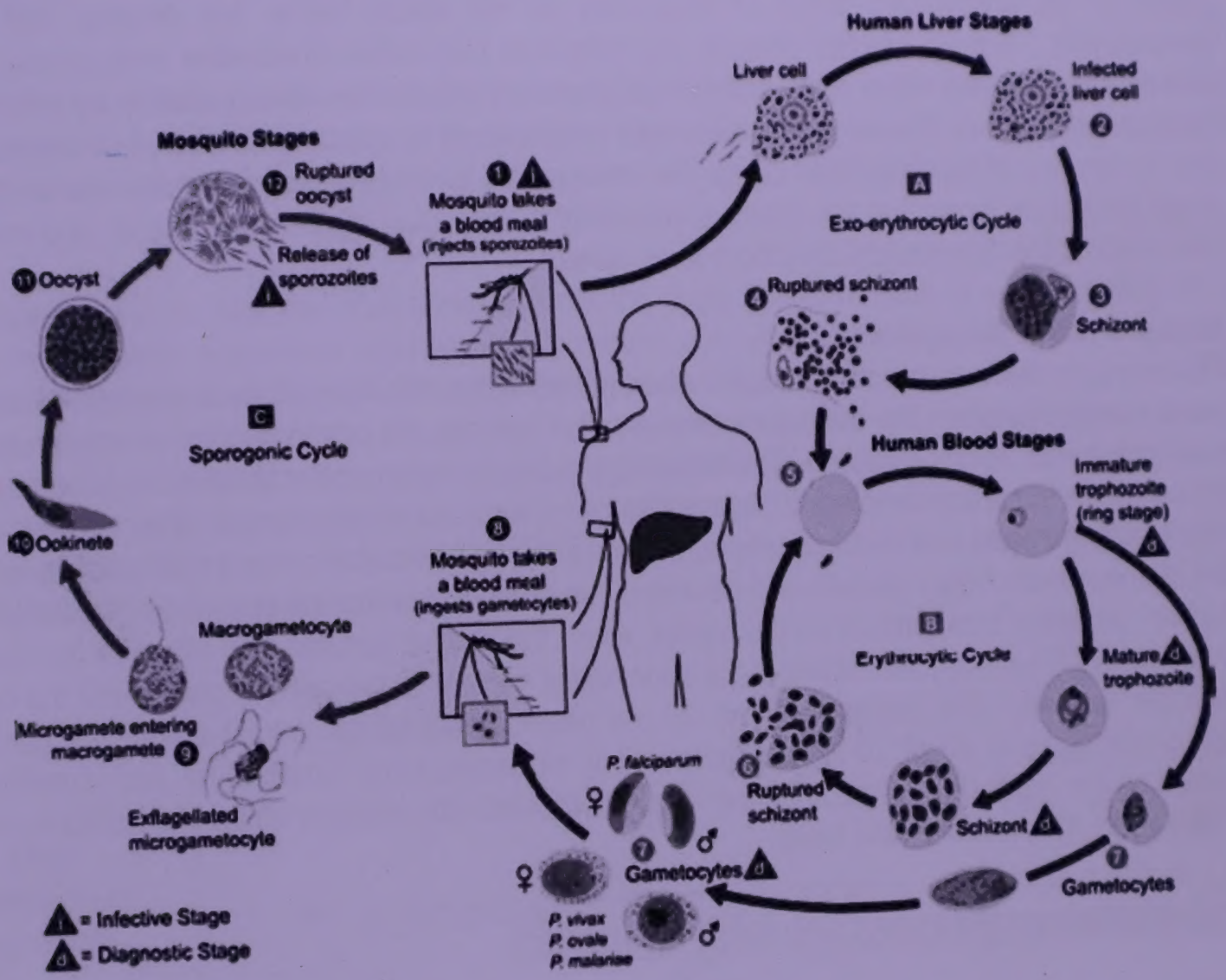


Figure 1.1. Life Cycle of *Plasmodium* species in man and the mosquito

Asexual cycle in human being
The asexual cycle begins when an infective anopheles mosquito bites a person and injects sporozoites. There are 3 phases in the human cycle.

Hepatic Phase:
The sporozoites disappear within 60 minutes from the peripheral circulation. Many of them are destroyed by phagocytes, but some reach the liver cells. After 1-2 weeks of development (depending upon the species), they become hepatic schizonts, which eventually burst releasing a shower of merozoites. The number of merozoites produced from a single sporozoite varies – as many as 40,000 in *P. falciparum*, whereas only 200 – 15,000 in other species. In *P. falciparum*, the intrahepatic schizonts rupture almost simultaneously and there is no persistent tissue phase (exo-erythrocytic phase). In the case of P. vivax, the hepatic forms may remain dormant (hypnozoites) for long periods, liberating merozoites at various intervals, causing relapses of malaria.

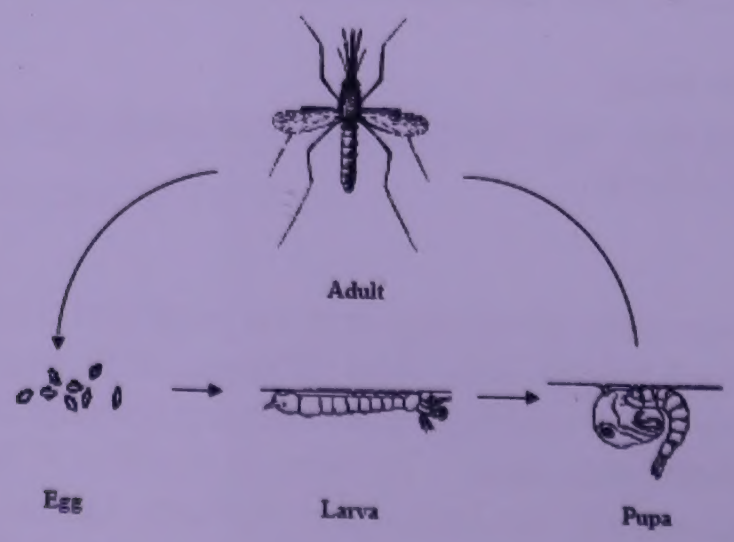
Erythrocytic Phase:
Many of the merozoites released from the liver cells are quickly destroyed, but a significant number attach themselves to specific receptor sites on the RBCs, penetrate them and pass through various stages of trophozoite and schizont. The erythrocytic phase ends with the liberation of merozoites, which infect fresh RBCs. The clinical feature of fever with chills coincides generally with the rupture of RBCs. The cycle is repeated over and over again until the condition worsens or when it may be slowed down by the immune response of the host. The duration of each erythrocytic cycle varies between species – 48 hours for *P. falciparum*, *P.vivax* and *P. ovale*; and 72 hours for *P. malariae*.

Gametogony:
Some of the erythrocytic forms of plasmodia do not divide further but develop into male and female gametocytes. Not all infected persons are infectious (can infect anopheline mosquitoes). The blood of the person has to have mature male and female gametocytes and the density should be minimum 12/ cu mm of blood to be infective. These gametocytes take over a week to appear in the blood. Gametocytes do not cause any symptoms in humans. Most drugs like chloroquine kill the asexual forms that cause the fever but leave intact the sexual forms that are infective especially in case of *P falciparum*. Thus an apparently normal person may harbour the disease and contribute to its spread.

Sexual Cycle in Mosquito:
The mosquito cycle (sporogony) begins when gametocytes are ingested by the vector mosquito while feeding on an infected person. The male gametocytes, after reaching the stomach of the mosquito and develop into 4-8 filaments called "microgametes". The female gametocyte undergoes maturation to become a "macrogamete". The microgametes get attracted to the macrogamete, and one of the microgametes fertilizes the macrogamete. The resulting zygote is at first motionless, but within 18-24 hours, becomes a motile ookinete, which penetrates the stomach wall of the mosquito and develops into an oocyst on the outer surface of the stomach. The oocyst further develops into numerous sporozoites, when the oocyst ruptures and releases the sporozoites into the body cavity of the mosquito. Many of the sporozoites migrate to the salivary glands and the mosquito becomes infective to man. The period required for the development of the parasite from the gametocyte stage to sporozoite stage is about 10-20 days depending on atmospheric temperature and humidity. This period is known as the "extrinsic incubation period". The sporozoites (the infective stage of *Plasmodium*) are injected with saliva when the mosquito next feeds.

1.2: VECTOR MOSQUITOES AND THEIR BIONOMICS

Life cycle of anopheline mosquitoes:



Eggs
The female anopheline mosquito requires a blood meal after mating for development of eggs. About 100-150 eggs are laid on the water surface during oviposition. The average lifespan of female anopheline mosquitoes is about 3-4 weeks.

Larva
The larvae hatch out from the eggs after about 1-2 days. There are four larval stages or instars.The anophelinelarva has no siphon and rests parallel to and immediately below the surface.The total duration of larval stage is generally 8-10 days at normal tropical water temperatures. At lower temperatures, the aquatic stages take longer time to develop.

Pupa
The pupa is shaped like a comma and it is a non feeding stage. It stays under the surface and swims down when disturbed. The pupal stage lasts for two to three days after which the skin of the pupa splits. Then the adult mosquito emerges and rests temporarily on the water's surface until it is able to fly.

Adult
Mating takes place soon after the adult emerges from the pupa. The first batch of eggs develops after one or two blood meals, while successive batches usually require only one blood meal. After the mosquito takes a blood meal she usually rests for a short period. Mosquitoes that enter a house usually rest on a wall, under furniture or on clothes hanging in the house after they bite and are said to be endophilic. Mosquitoes that bite outside usually rest on plants, in tree holes, on the ground or in other cool dark places and are called exophilic. Mosquitoes which prefer human blood are known as anthropophilicwhile mosquitoes preferring animal blood are known as zoophilic. Clearly, those who prefer to take human blood are the most dangerous as they are more likely to transmit malaria from person to person.

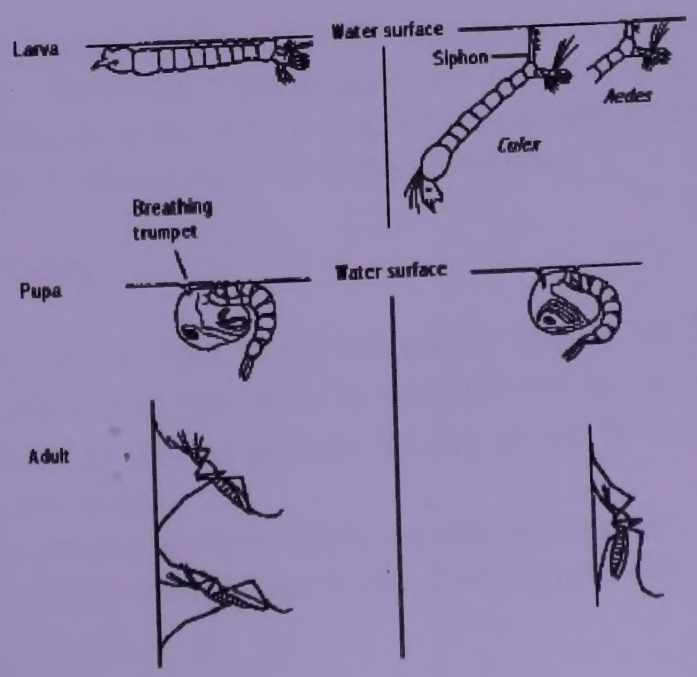
Anophelines

Eggs: Float separately; each egg has a float

Larva: No siphon and rests parallel and immediately below surface

Pupa: Breathing trumpet short and has wide opening

Adult: Rest at an angle between 50° and 90° to the surface



Culicines

Egg: Clump together in a raft (*Culex*) or float separately (*Aedes*)

Larva: Breathing tube (siphon), also used to hang down from surface

Pupa: Breathing trumpet long and slender with a narrow opening

Adult: Rest more or less parallel to the surface

Figure 1.2 Distinguishing features between anophelines from culicines

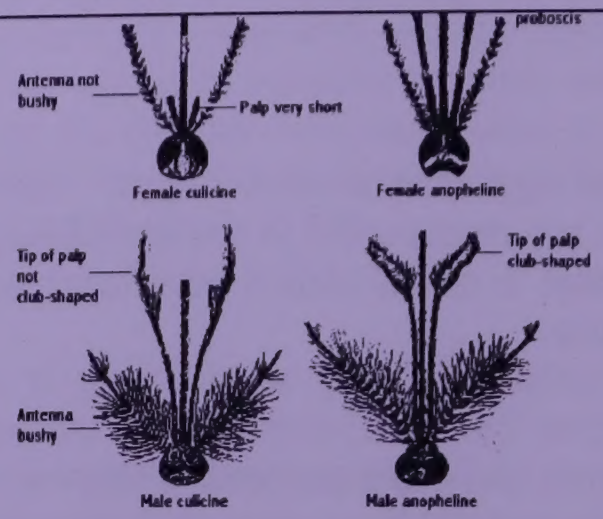
Antennae of Female mosquitoes

Hairs few in number and short

Palpi

Female culicine:
Palpi much shorter than proboscis

Male culicine:
Palpi longer than proboscis, with tapered tips



Palpi

Female anopheline:
Palpi as long as proboscis

Male anopheline:
Palpi as long as proboscis and club-shaped at tip

Antennae of Male mosquitoes

Hairs very long, giving bushy appearance

Figure 1.3: Distinguishing *Anopheles* females from males

Entomological parameters:

- Entomological parameters should be correlated with epidemiological parameters to get a complete picture of malaria in the area.

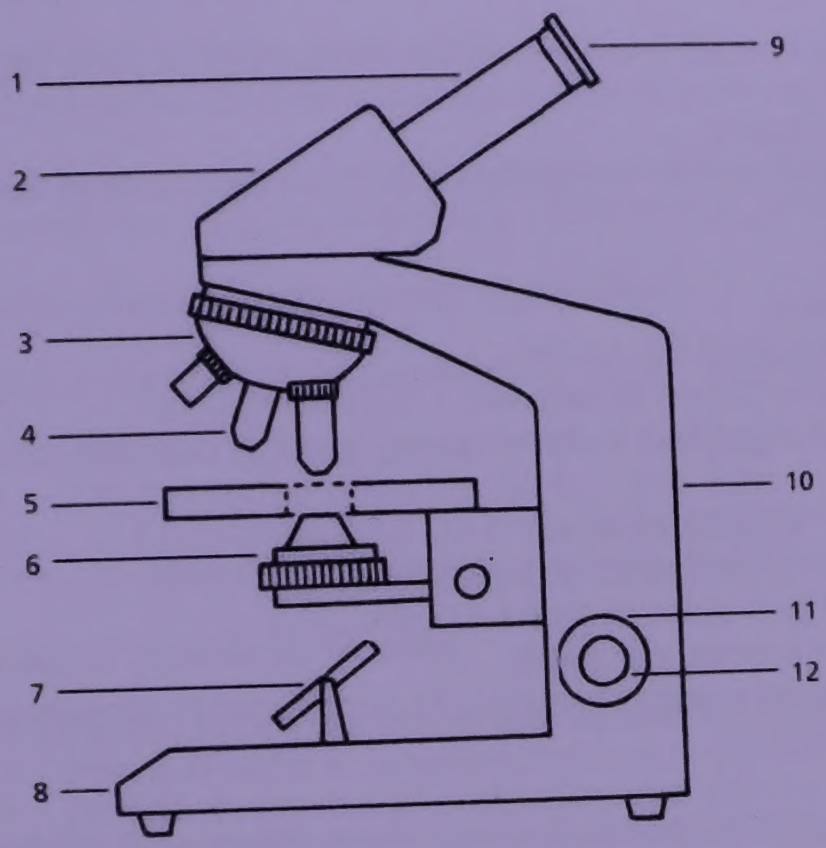
2: LABORATORY DIAGNOSIS OF MALARIA AND SUPERVISION OF LABORATORY SERVICES

2.1 Importance of microscopy for management of malaria cases

The whole edifice of malaria control is based on accurate and prompt diagnosis of malaria in fever cases.

- Diagnosis of all fever cases suspected to be malaria must be confirmed by microscopy or RDT.
- The PHC laboratory/malaria clinic becomes the central point to maintain required levels of efficiency and accuracy of microscopic examination.
- The strategy of malaria control is influenced by parasite species and its distribution in the community.

2.2 Use of the microscope



Parts of a typical compound microscope

1. Main tube
2. Body tube (prism) } inclined head
3. Revolving nosepiece
4. Objective
5. Stage (mechanical stage)
6. Substage condenser with iris diaphragm
7. Mirror
8. Base (foot)
9. Ocular (eyepiece)
10. Arm (limb)
11. Coarse adjustment
12. Fine adjustment

A lens combination of a 5x eyepiece and a 100x Oil immersion objective would give a total magnification of 500x (with Tube factor = 1), Binocular microscopes are easier and less tiring to use, particularly for long periods. When a mirror is used with artificial light, the flat side should be used; when daylight is the light source, the concave side should be used without the sub-stage condenser.

Essential aspects of microscopy

- The window for incoming natural light in the laboratory should be preferably in north or south direction. Otherwise, artificial light with a blue filter is to be used for conducting the microscopy work.
- Adequate amounts of natural as well as artificial lighting should be available in the laboratory
- Working table with adequate space
- Revolving stool for the lab technician with height adjustment mechanism
- Adequate facilities for laboratory record, chemicals, cleaning of slides, staining, etc.

Condition of Microscope

- Oil-immersion lens and eye-piece free from dust, dirt or opacity
- Coarse and fine adjustments in good working condition
- Mechanical stage moving without jerks / zigzag movement

Care of the microscope

- Always keep the microscope covered with a clean plastic or cloth cover when it is not in use to protect it from dust, especially in hot dry climates
- Protect microscope from fungus growth in warm humid climate by either:
    - Storing it in a continuously air-conditioned or de-humidified room or
    - Fixing a 15- watt bulb, which is left constantly lit, in the microscope box or
    - Connecting a number of 15- or 25-watt bulbs, left constantly lit, inside a cupboard with tightly fitting doors
- Clean the immersion oil from the immersion objective every day

Cleaning and storing microscope slides

- New slides should be soaked in water with detergent for 30-60 minutes and then rinsed several times under running tap water. Dry each slide using a clean, lint-free cloth.
- Previously used slides must be soaked for at least 1 hour in hypochlorite solution before being washed and dried.
- Slides for preparation of blood films must be scrupulously clean and free from moisture, grease and scratches.

Checking random samples of blood smears

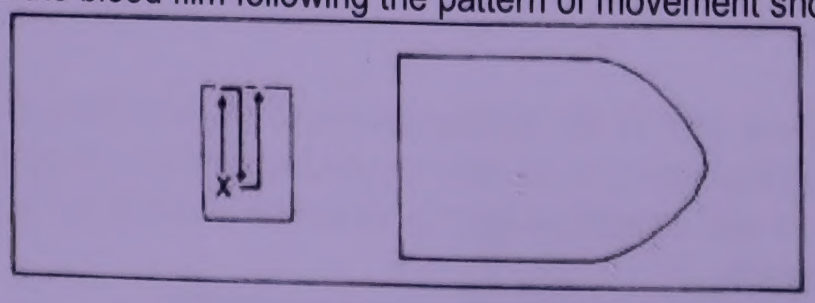
Random samples of blood smears to be picked up from slides stained over the preceding week. At least 20-25 slides to be checked for the following:

- Presence of both thick and thin smears
- Serial number of the slide: clearly legible on thin smear
- The quality of smear and staining to be judged visually with a white background
- Thick smear to have adequate blood about 1cm in diameter and have light blue staincolour with violet iridescence
- Thin smear to be single layered and tongue shaped
- Glass slides to be free from dust, dirt, greasy spots and scratches
- Staining and artifacts to be checked from slides of each subcentre
- Random confirmation of positives for species and stages
- Re-examination/confirmation of all blood smears of severe and complicated *P. falciparum*infection for species, stages and density of parasites.

2.3 Examination of blood films for malaria parasites (various blood stages of *P. falciparum* and *P.vivax* are shown in Plates 1 and 2 respectively)

Examination of thick films

Examine 100 fields, following the pattern of movement shown. To assist in examination, use a hand tally counter to count fields. Record findings on the appropriate record form. A parasite count may be included.Examine the blood film following the pattern of movement shown.

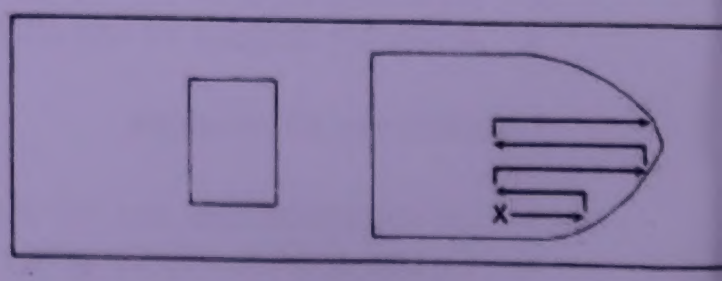


Examination of thin films

It is usually in the distal third of the blood film that cells are:

- Most evenly distributed
- In a single layer and
- Have minimum distortion

Examine the blood film following the pattern of movement shown.



Examination of thin films may be necessary for confirmation of species identification or when thick films have been poorly prepared.

Methods of counting malaria parasites in thick blood films

It is often necessary to determine the density of malaria parasites in thick blood films so that the physician is aware of the severity of the infection and the parasites are responding to treatment. Two methods are employed to count the parasites in thick blood films:

1) Determination of parasites μ / ml of blood

(a) If, after counting 200 leukocytes, 10 or more parasites are found, record the results in terms of number of parasites / 200 leukocytes. Using a formula, multiplying the number of parasites by 8000 (taken as standard number of leukocytes / μl of blood) and then dividing this figure by the number of leukocytes counted, the parasites /μl of blood is determined, for example,

If 200 leukocytes are counted and 25 parasites are counted,
(25 parasites x 8000/200 leukocytes) = 1000 parasites /μl of blood

(b) If after counting 200 leukocytes, the number of parasites is 9 or fewer, continue counting until you reach 500 leukocytes and then record the number of parasites/500 leukocytes.

If 500 leukocytes are counted and 5 parasites are counted,
(5 parasites x 8000/500 leukocytes) = 80 parasites /μl of blood

2) Plus system (Recording the density of parasites):

A simpler method, albeit less satisfactory, entails using a code of between one and four plus signs, as follows:

+	=	1 - 10 parasites per 100 thick film fields
++	=	11 - 100 parasites per 100 thick film fields
+++	=	1 - 10 parasites per single thick film field
++++	=	More than 10 parasites per single thick film field

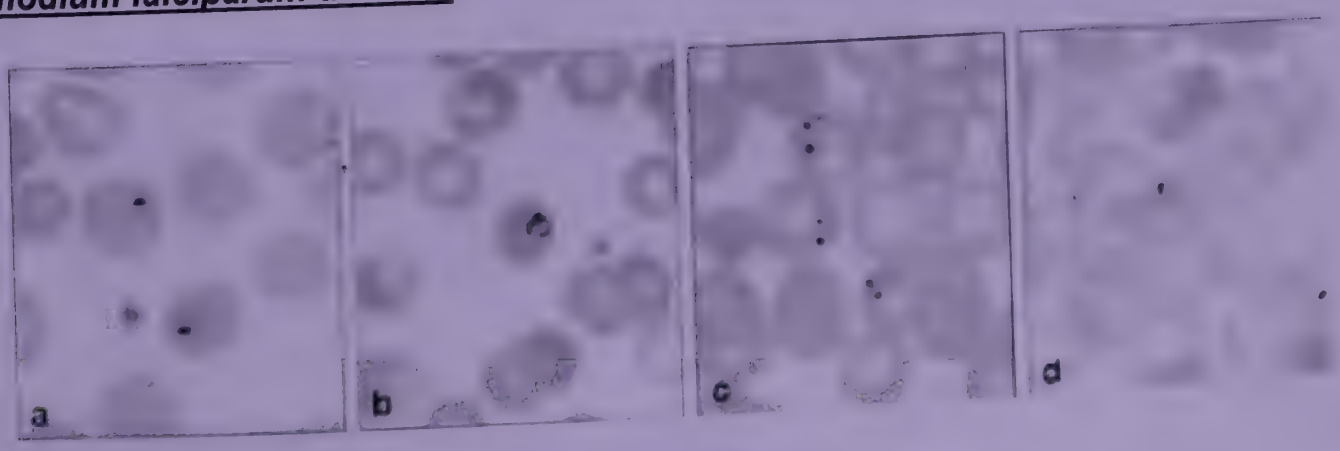
2.4 Inspection of records for time lag

A sample of M - 4 forms should also be seen especially to note the time taken between:

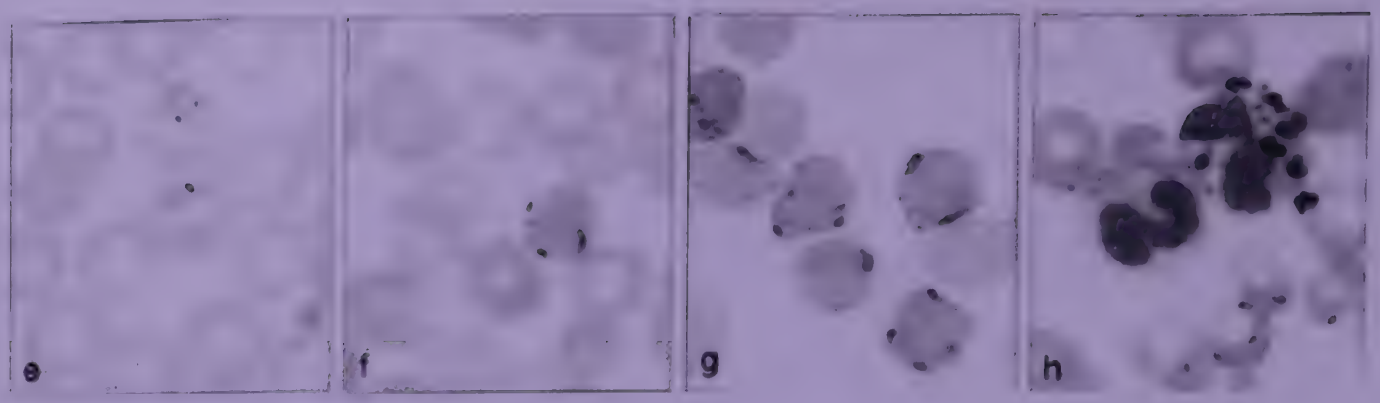
- Making of slides at periphery to receipt at the laboratory
- Period between receipt in laboratory and staining
- Period between staining and examination of slides
- Period between examination of slides and dispatch of results to the periphery for effective treatment

Necessary supervision must be exercised by MO-PHC over the lab technician and corrective action taken for minimizing time lag between slide making and receipt of report by health provider.

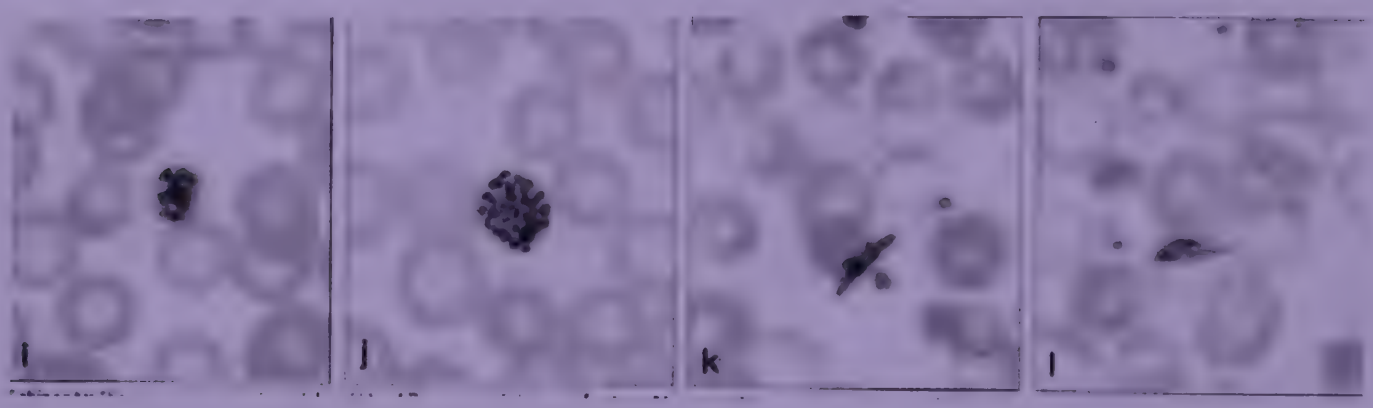
Plate 1: *Plasmodium falciparum* thin film



a, b: Trophozoites are small, with thin ring of cytoplasm, a vacuoleand prominent chromatin dot
c: Red cells with double chromatin dots is a frequent feature.
d: Parasites at margin of red cells referred to as accole or appliqué forms



f,h: Multiple invasion of erythrocytes is a frequent feature
f, g: Sometimes marginal forms displaced markedly with parasite extending beyond cell margin



I, j: Mature schizonts are compact containing 16 to 24 merozoites
K, l: Gametocytes, initially spindle-shaped
m-o: Develop into banana- or sausage-shaped bodies with rounded ends.
m-n: chromatin concentrated as a mass
o: pigment tends to be more scattered
p: occasionally, gametocytes assume bizarre shapes
Gametocytes are only usually seen in peripheral blood smear in P. falciparum infections. Trophozoites and schizontsare seen only when infection is severe with high parasitaemia.

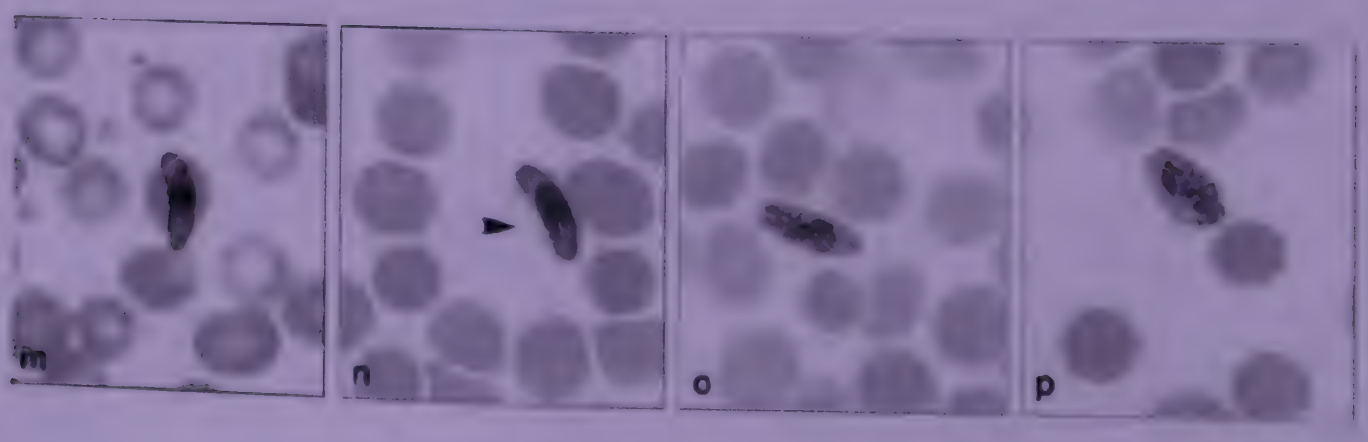
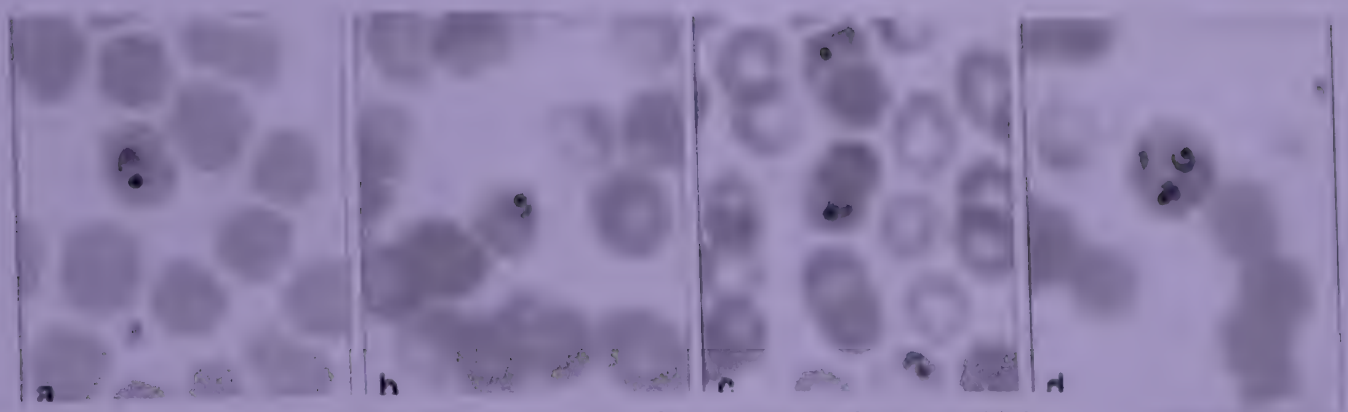
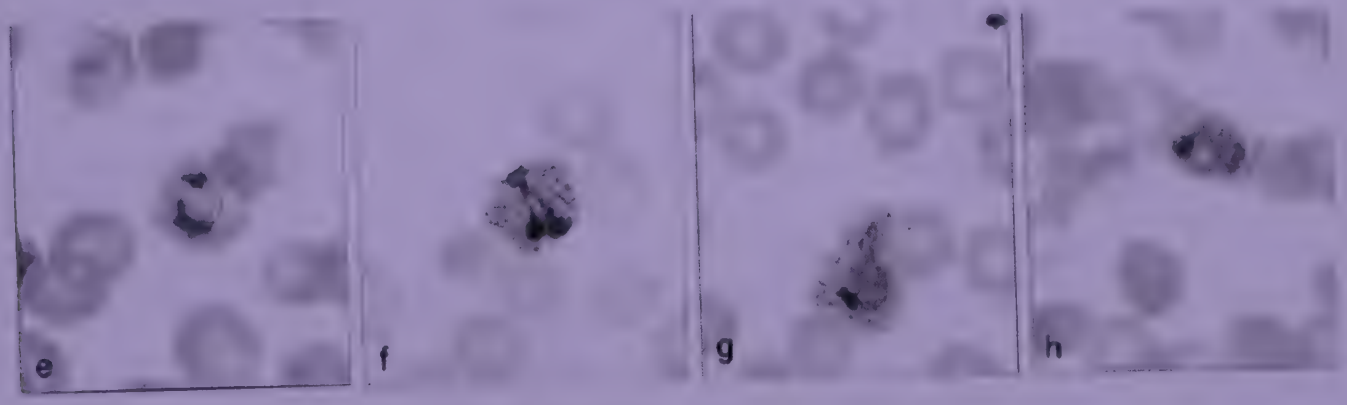


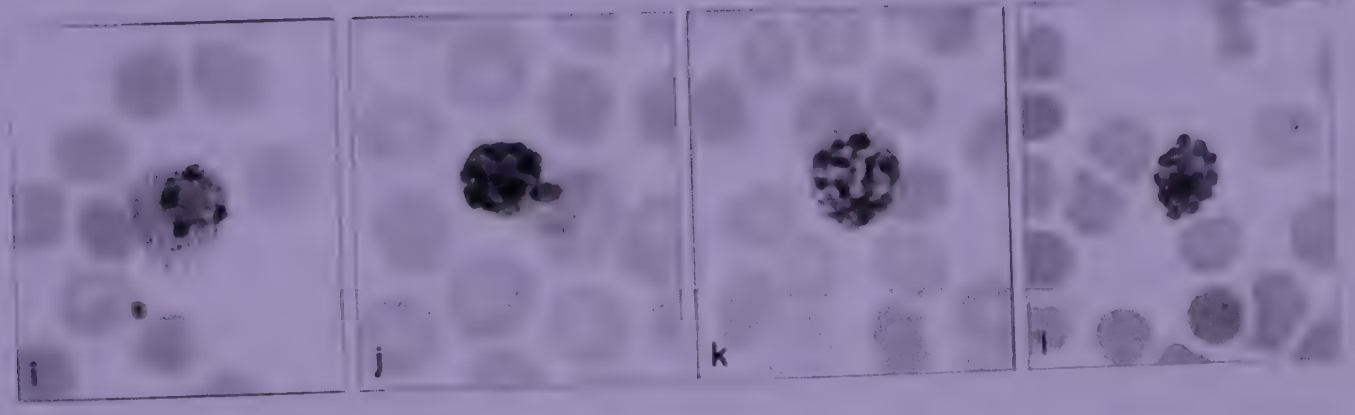
Plate 2: *Plasmodium vivax* thin film



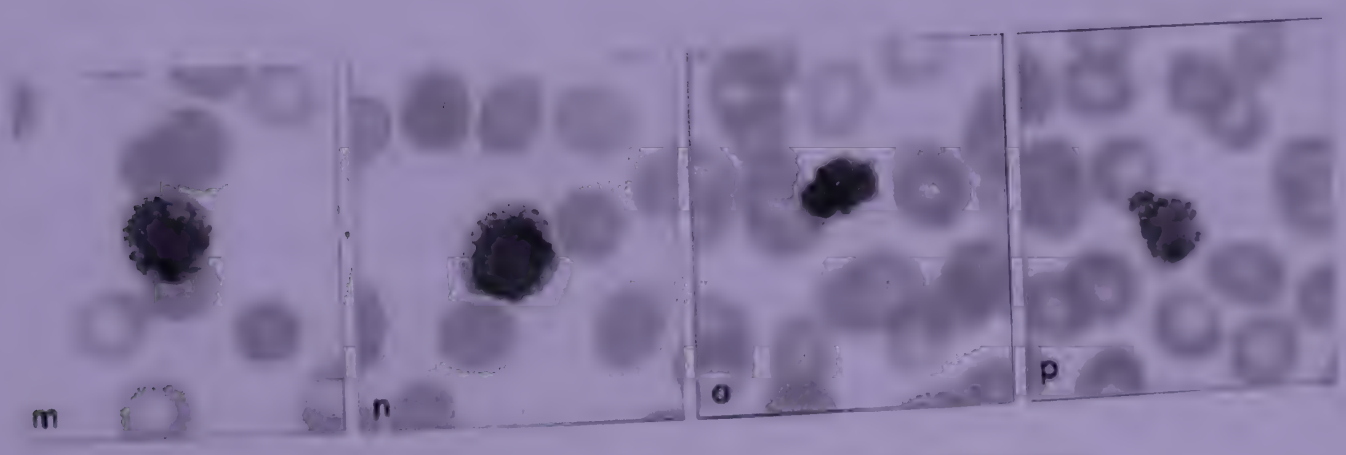
a - d: Infected RBCs become enlarged by > 50% in size. Ring form measure about one-third diameter of RBCs. Have prominent red chromatin and fine circle of blue cytoplasm



e: Young trophozoites have irregular, amoeboid appearance; Scuffner's dots seen
f-g: Older trophozoites become very large, markedly amoeboid and may fill RBC
h: Chromatin mass is large and compact with grains of pigment scattered throughout cytoplasm



i: The early schizont is large and amoeboid
j - l: Chromatin divides into small irregular masses ultimately forming 12-24 merozoites; mature schizont fills enlarged RBC

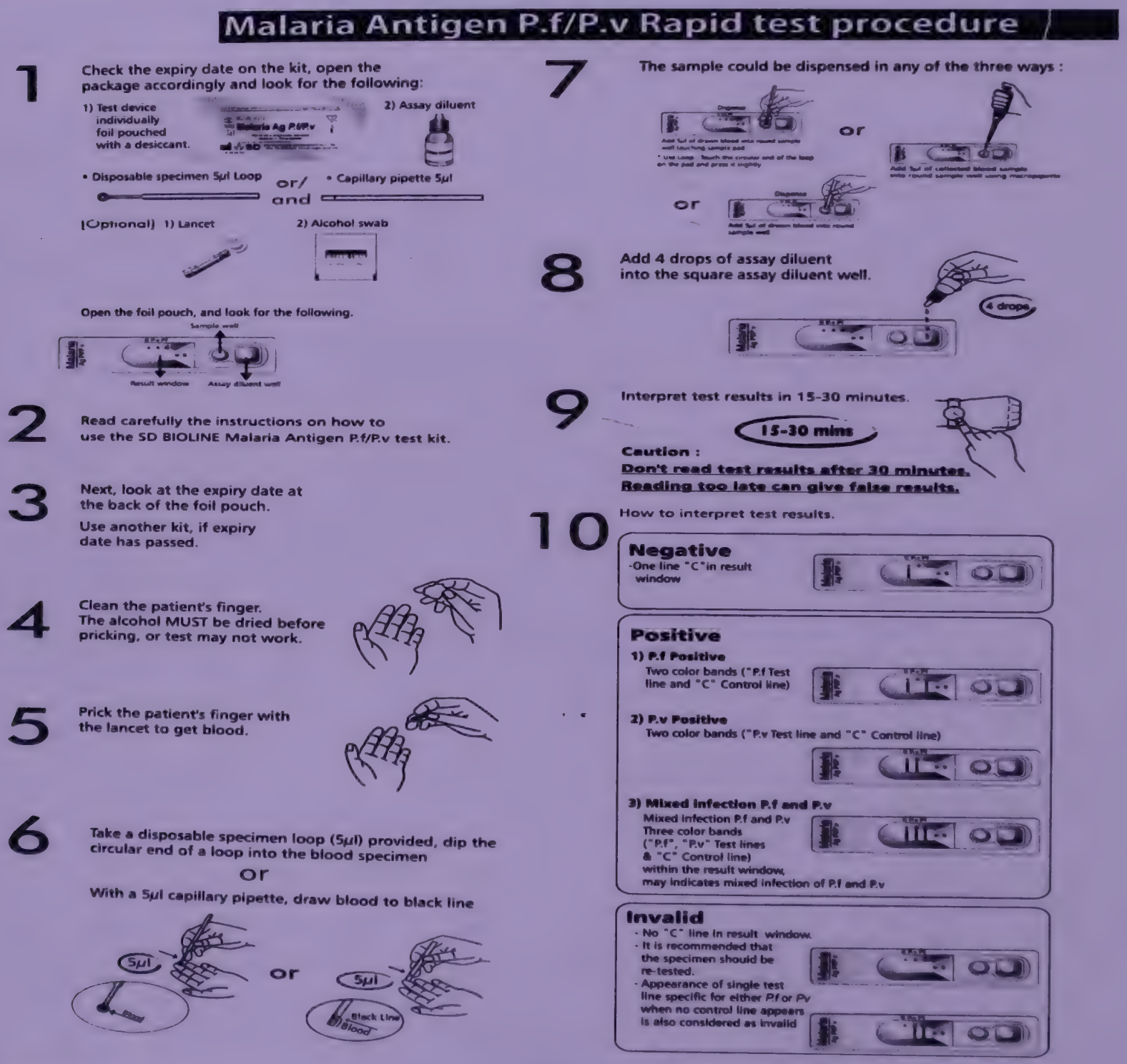


M-n: Macrogametocytes are large and blue and have small, eccentric compact chromatin mass; brown pigment is scattered throughout cytoplasm. Parasite nearly fills enlarged RBC.
o - p: Microgametocytes have large, diffuse mass of pink staining chromatin and light blue cytoplasm containing scattered granules of dark pigment

2.5 Rapid Diagnosis Test (RDT)

The Rapid Diagnosis Tests are based on the principle of immunochromatography and detect the plasmodium antigen if present in blood. There are different types of test kits. Some detect only P.falciparum. Some detect both P. falciparum and P. vivax. The tests are available in two formats basically –dipstick type and the card type.

Currently card type kits capable of detecting both P. falciparum and P. vivax are being used in the programme. The procedure is explained below:


Malaria Antigen P.f/P.v Rapid test procedure
1
Check the expiry date on the kit, open the package accordingly and look for the following:
1) Test device individually foil pouched with a desiccant.
2) Assay diluent
• Disposable specimen 5µl Loop
or/ and
• Capillary pipette 5µl
[Optional] 1) Lancet
2) Alcohol swab
Open the foil pouch, and look for the following.
Sample well
Result window
Assay diluent well
2
Read carefully the instructions on how to use the SD BIOLINE Malaria Antigen P.f/P.v test kit.
3
Next, look at the expiry date at the back of the foil pouch.
Use another kit, if expiry date has passed.
4
Clean the patient's finger.
The alcohol MUST be dried before pricking, or test may not work.
5
Prick the patient's finger with the lancet to get blood.
6
Take a disposable specimen loop (5µl) provided, dip the circular end of a loop into the blood specimen
or
With a 5µl capillary pipette, draw blood to black line
5µl
Blood
or
5µl
Black Line
Blood
7
The sample could be dispensed in any of the three ways :
or
or
8
Add 4 drops of assay diluent into the square assay diluent well.
4 drops
9
Interpret test results in 15-30 minutes.
15-30 mins
Caution :
Don't read test results after 30 minutes.
Reading too late can give false results.
10
How to interpret test results.
Negative
-One line "C"in result window
Positive
1) P.f Positive
Two color bands ("P.f Test line and "C" Control line)
2) P.v Positive
Two color bands ("P.v Test line and "C" Control line)
3) Mixed Infection P.f and P.v
Mixed infection P.f and P.v
Three color bands
("P.f", "P.v" Test lines
& "C" Control line)
within the result window,
may indicates mixed infection of P.f and P.v
Invalid
- No "C" line in result window
- It is recommended that the specimen should be re-tested.
- Appearance of single test line specific for either P.f or P.v when no control line appears is also considered as invalid

2.6 Mechanisms to expedite slide transportation and reporting

As obtaining the results of the slide examination are crucial for effective treatment, all options to expedite slide transportation and reporting are required to be explored and utilized. These options may be use of local bus or any other vehicle making daily trips to the block HQ town, the postal system, daily migrant workers proceeding from the village to the town, school children from the villages etc. For obtaining the results from the laboratory, all these measures may be utilized and in addition, telephones (landline/mobile/SMS) may be used.

Mechanisms have to be built in to ensure that the slides not only reach the block HQ town but also the laboratory and report reaches back.

It should also be ensured that the slide numbering system and data entry are simple enough for the ASHA/community volunteer to comprehend and act. The reporting should also be clear and unambiguous for the ASHA/community volunteer to read and interpret correctly. If any reporting is done over the phone, special attention should be paid for identification of the patient correctly. The ASHA/community volunteer must all care to ensure that the slides are protected from any damage en route.

2.7 Infection control practices while preparing blood smears or doing RDT:

Blood from patients can contain organisms that can cause different diseases like HIV/AIDS, hepatitis etc. Therefore any material which has been contaminated by blood, such as swabs, lancets, used and discarded slides, test strips and test tubes should be handled with care as per standard guidelines.

- Wash your hands thoroughly with soap and water before you draw blood.
- Use surgical gloves. Gloves provide a barrier against potentially infectious microorganisms that can be found in blood, other body fluids, and waste.
- Always use a fresh lancet for each test.
- Do not touch the sharp tip of the lancet before or during the process of drawing blood.
- Do not touch blood with bare fingers at any time.
- Take care to ensure that you do not prick yourself accidentally with a used lancet.
- After the test is over, wash your hands again thoroughly with soap and water.
- Dispose of all used materials in the plastic bag (blue or white translucent) and handle the waste carefully as per proper waste management principles.

Disposal of used lancets:

During the surveillance activity, blood smears are being collected using the disposable lancets. It is imperative that the used lancets are properly disposed of. They should not be thrown here and there. The used lancets must be dipped in 1% Chlorine Solution for at least half an hour.A chlorine solution can be made from liquid household bleach (sodium hypochlorite) or from chlorine compounds available in powder (calcium hypochlorite or chlorinated lime) or tablet (sodium dichloroisocyanurate) form. *Because of the low cost and wide availability, chlorine solutions prepared from liquid or powdered bleach are recommended for decontamination.* Liquid bleach and chlorine-containing compounds are described as having a certain percentage of 'active' (or available) chlorine. It is the 'active' chlorine in these products that kills microorganisms. The amount of 'active' chlorine is usually described as a percentage, and differs from one product to another. This is important so that a chlorine solution with the appropriate percentage of 'active' chlorine can be prepared.

Using bleach solution: If sodium hypochlorite solution is used, the following formula may be used to calculate the dilution with water:
(% of available chlorine in the bleach solution) -1 = Amount of water required for dilution

Example: If the bleach solution has 3.5 % available chlorine, then 3.5 -1 i.e., 2.5 parts of water are required to be mixed with one part of bleach solution..

Using Bleaching Powder:
If using bleach powder, calculate the ratio of bleach to water using the following formula:

[% chlorine desired] divided by [% chlorine in bleach powder] x 1,000 = Number of grams of powder for each litre of water

Example: To make a 1% chlorine solution from calcium hypochlorite powder containing 35% available chlorine: [1%] divided by[35%] x 1,000 = 0.0286 x 1,000 = 28.6

Therefore, you must dissolve about 30 gms of calcium hypochlorite powder in 1 litre of water in order to get a 1% chlorine solution.

Prepare a new chlorine solution at the beginning of each day or when the solution looks like it needs to be changed, such as when the solution becomes heavily contaminated with blood or other body fluid or becomes cloudy. (Note that when bleach powder is used, the solution is likely to be cloudy at the start.)

Remember: Wear utility gloves whenever you handle chlorine, used surgical instruments, and other items for decontamination.

They should be buried in a deep pit in the ground away from wells and other sources of water in an identified spot at the subcenter /PHC.

3: MALARIA CASE MANAGEMENT

3.1 Antimalarial drugs:

Chloroquine

Chloroquine is a 4-aminoquinoline used extensively for treatment and prevention of malaria. Widespread resistance has now rendered it ineffective against *P. falciparum* in most parts of the world, although it still maintains considerable efficacy for treatment of other species of malaria. Chloroquine interferes with parasite haem-detoxification. Resistance is related to genetic changes in transporters (PfCRT, PfMDR), which reduce the concentrations of chloroquine at its site of action, the parasite food vacuole. The principal limiting adverse effects in practice are the unpleasant taste, which may upset children, and pruritus, which may be severe in dark-skinned patients. Other less common side effects include headache, various skin eruptions and gastrointestinal disturbances, such as nausea, vomiting and diarrhea.

Amodiaquine

Amodiaquine is a 4-aminoquinoline with a mode of action similar to that of chloroquine. Its adverse effects are also similar to those of chloroquine. Amodiaquine is associated with less pruritus and is more palatable than chloroquine. It is associated with a much higher risk of agranulocytosis and, to a lesser degree, of hepatitis when used for prophylaxis.

Sulfadoxine

Sulfadoxine is a slowly eliminated sulfonamide which is a competitive inhibitor of dihydropteroate synthase, the bacterial enzyme responsible for incorporation of p-amino benzoic acid in the synthesis of folic acid. Sulfadoxine is used in a fixed-dose combination of 20 parts of sulfadoxine with 1 part of pyrimethamine. Hypersensitivity reactions can be severe because of its slow elimination and may affect different organ systems. Nausea, vomiting, anorexia and diarrhea may occur. Cutaneous manifestations can be severe and include pruritus, photosensitivity reactions, exfoliative dermatitis, erythema nodosum, toxic epidermal necrolysis and Stevens-Johnson syndrome. Treatment with sulfadoxine should be stopped in any patient developing a rash because of the risk of severe allergic reactions.

Pyrimethamine

Pyrimethamine is a diaminopyrimidine used in combination with a sulfonamide and it exerts its antimalarial activity by inhibiting plasmodialdihydrofolate reductase thus blocking the synthesis of nucleic acids in the malarial parasite. Pyrimethamine is generally very well tolerated. Administration for prolonged periods may cause depression of haematopoiesis due to interference with folic acid metabolism. Skin rashes and hypersensitivity reactions also occur.

Mefloquine

Mefloquine is a 4-methanolquinoline and is related to quinine. It is effective against all forms of malaria. Minor adverse effects are common following mefloquine treatment, most frequently nausea, vomiting, abdominal pain, anorexia, diarrhea, headache, dizziness, loss of balance, dysphoria, somnolence and sleep disorders, notably insomnia and abnormal dreams. Neuropsychiatric disturbances (seizures, encephalopathy, psychosis) are less common but are more severe.

Artemisinin and its derivatives

Artemisinin

Artemisinin, also known as qinghaosu, is a sesquiterpene lactone extracted from the leaves of Artemisia annua (sweet wormwood). It has been used in China for thetreatment of fever for over a thousand years. It is a potent

and rapidly acting blood schizonticide and is active against all Plasmodium species. It has an unusually broad activity against asxual parasites, killing all stages from young rings to schizonts. In *P. falciparum* malaria, artemisinin also kills the gametocytes – including the stage 4 gametocytes, which are otherwise sensitive only to primaquine. Artemisinin and its derivatives inhibit an essential calcium adenosine triphosphatase, PfATPase 6. Artemisinin has now largely given way to the more potent dihydroartemisinin and its derivatives, artemether, artemotil and artesunate. These drugs should be given as combination therapy to protect them from resistance. A wide variety of formulations for oral, parenteral and rectal use are available.

Artemisinin and its derivatives are safe and remarkably well tolerated. There have been reports of mild gastrointestinal disturbances, dizziness, tinnitus, reticulocytopenia, elevated liver enzyme values and electrocardiographic abnormalities. The only potential serious adverse effect reported is type 1 hypersensitivity reactions in approximately 1 in 3,000 patients. Artemisinin has not been evaluated in the first trimester of pregnancy so should be avoided in first trimester patients with uncomplicated malaria until more information is available.

Artemether

Artemether is the methyl ether of dihydroartemisinin. It can be given as an oil-based intramuscular injection or orally. It is also coformulated with lumefantrine for combination therapy, as tablets containing 20 mg of artemether and 120 mg of lumefantrine.

Artesunate

Artesunate is the sodium salt of the hemisuccinate ester of artemisinin. Artesunate can be given orally, rectally or by the intramuscular or intravenous routes. In India Artesunate is available under the National Vector Borne Diseases Control Programme (NVBDCP) for combination therapy with Sulfadoxine-Pyrimethamine.Artesunate-Mefloquine and Artesunate-Mefloquine are the other ACTs used which include Artesunate.

Dihydroartemisinin

Dihydroartemisinin is the main active metabolite of the artemisinin derivatives, but can also be given orally and rectally as a drug in its own right. A fixed dose formulation with piperaquine is currently undergoing evaluation as a promising new ACT.

Artemotil

Artemotil, previously known as arteether, is the ethyl ether of artemisinin. It is given by intravenous injection only and is provided by the NVBDCP.

Lumefantrine

Lumefantrine belongs to the aryl aminoalcohol group of antimalarials, which also includes quinine, mefloquine and halofantrine. It is only available in an oral preparation coformulated with artemether. This ACT is highly effective against multidrug-resistant *P. falciparum*. The drug is remarkably well tolerated.

Primaquine

Primaquine is an 8-aminoquinoline which is effective against intrahepatic forms of all types of malaria parasite. It is used to provide radical cure of *P. vivax* and *P. ovale* malaria, in combination with a blood schizonticide for the erythrocytic parasites. Primaquine is also gametocytocidal against *P. falciparum* and has significant blood stage activity against *P. vivax* (and some activity against asexual stages of *P. falciparum*). The mechanism of action is unknown. The most important adverse effects are haemolyticanaemia in patients with G6PD deficiency, other defects of the erythrocytic pentose phosphate pathway of glucose metabolism, or some types of haemoglobinopathy. Therapeutic doses may also cause abdominal pain if administered on an empty stomach. Larger doses can cause nausea and vomiting. Methaemoglobinemia may occur.

Quinine

Quinine is an alkaloid derived from the bark of the Cinchona tree. It acts principally on the mature trophozoite stage of parasite development and does not prevent sequestration or further development of circulating ring stages of *P. falciparum*. It also kills the sexual stages of *P. vivax*, *P. malariae* and *P. ovale*, but not mature gametocytes of *P. falciparum*. It does not kill the pre-erythrocytic stages of malaria parasites.

Quinine is available as quinine hydrochloride, quinine dihydrochloride , quinine sulphate and quinine bisulphate tablets. It is also available as quinine hydrochloride, quinine dihydrochloride and quinine sulfate injectable solutions.

Administration of quinine or its salts regularly causes a complex of symptoms known as cinchonism, which is characterized in its mild form by tinnitus, impaired high tone hearing, headache, nausea, dizziness and dysphoria, and sometimes disturbed vision. More severe manifestations include vomiting, abdominal pain, diarrhea and severe vertigo. Hypersensitivity reactions to quinine range from urticaria, bronchospasm, flushing of the skin and fever, through antibody-mediated thrombocytopenia and hemolytic anemia, to life-threatening haemolytic-uremic syndrome. Massive haemolysis with renal failure (black water fever) has been linked epidemiologically and historically to quinine. The most important adverse effect in the treatment of severe malaria is hyperinsulinaemichypoglycaemia which is particularly common in pregnancy.

3.2 Clinical features and management of malaria:

Fever is the cardinal symptom of malaria. It can be intermittent with or without periodicity or continuous. Many cases have chills and rigors. The fever is often accompanied by headache, myalgia, arthralgia, anorexia, nausea and vomiting. The symptoms of malaria can be non-specific and mimic other diseases like viral infections, enteric fever etc. Malaria should be suspected in patients residing in endemicareas and presenting with above symptoms. It should also be suspected in those patients who have recently visited an endemic area. Although malaria is known to mimic the signs and symptoms of many common infectious diseases, the other causes should also be suspected and investigated in the presence of following manifestations:

- Running nose, cough and other signs of respiratory infection
- Diarrhoea/dysentery
- Burning micturition and/or lower abdominal pain
- Skin rash/infections
- Abscess
- Painful swelling of joints
- Ear discharge
- Lymphadenopathy

All clinically suspected malaria cases should be investigatedimmediately by microscopy and/or Rapid Diagnostic Test (RDT).

3.3. Diagnosis

3.3.1 Microscopy

Microscopy of stained thick and thin blood smears remains the gold standard for confirmation of diagnosis of malaria. The advantages of microscopy are:

• The sensitivity is high. It is possible to detect malaria parasites at low densities. It also helps to quantify the parasite load.

• It is possible to distinguish the various species of malaria parasite and their different stages.

3.3.2 Rapid Diagnostic Test

Rapid Diagnostic Tests are based on the detection of circulating parasite antigens. The bivalent RDTs supplement and help in immediate diagnosis and prompt treatment in areas from where microscopy facility is not readily accessible or microscopy results are likely to be delayed; but can never replace microscopy which is still considered the gold standard for diagnosis of malaria. It is also to be noted that whenever the RDT is conducted on any fever case, blood smear should always be taken simultaneously. It is only the blood smear that shows the stage and density of the parasite.

The user's manual should always be read properly and instructions followed meticulously. The results should be read at the specified time. It is the responsibility of the health care personnel doing a rapid test for malaria to ensure that the kit is within its expiry date and has been transported and stored under recommended conditions. Failure to observe these criteria can lead to false/negative results. It should be noted that Pf HRP-2 based kits may showpositive result up to three weeks after successful treatment.

An RDT is done in front of the patient and a slide is taken. The bivalent RDT detects *Pv, Pf* as well as mixed infection. If it is positive, the patient is treated for falciparum or vivax malaria based on the diagnosis and the slide is discarded in order to reduce the load on the microscopy services. It should be noted that these tests have a short shelf-life and that they may deteriorate at high temperatures. Some manufacturers are now indicating that their product has a longer shelf-life. Although this is encouraging, malaria control staff and medical officers should manage rapid diagnostic test kits (RDKs) under the assumption that the shelf-life is 24 months.

3.4. Treatment of uncomplicated malaria

All fever cases diagnosed as malaria by RDT or microscopy should promptly be given effective treatment.

3.4.1 Treatment of P. vivax malaria

Confirmed P. vivax cases should be treated with chloroquine in full therapeutic dose of 25 mg/kg divided over three days. In some patients, P. vivax may cause relapse (A form of P. vivax or P. ovale parasites called as hypnozoites remain dormant in the liver cells. These hypnozoites can later cause a relapse). For its prevention, primaquine should be given at a dose of 0.25 mg/kg body weight daily for 14 days under supervision. Primaquine is contraindicated in known G6PD deficient patients, infants and pregnant women. Caution should be exercised before administering primaquine in areas known to have high prevalence of G6PD deficiency, therefore, it should be tested if facilities are available. Primaquine can lead to hemolysis in G6PD deficiency. Patient should be advised to stop primaquine immediately if he/she develops symptoms like dark coloured urine, yellow conjunctiva, bluish discolouration of lips, abdominal pain, nausea, vomiting etc. and should report to the doctor immediately.

Table Chloroquine dosage schedule for *P. vivax* cases

Age in years	Day – 1 (10mg/Kg) or tablets	Day – 2 (10mg/Kg) or tablets	Day – 3 (5 mg/Kg) or tablets
<1	½	½	¼
1 – 4	1	1	½
5 – 8	2	2	1
9 – 14	3	3	1½

15 & above	4	4	2

Table Primaquine dosage schedule for *P. vivax* cases

Age in years	Daily dose for 14 days		
	Daily dosage (in mg of base)	No. of Tablets (2.5 mg base)	No. of Tablets (7.5 mg base)
< 1	Nil	Nil	Nil
1 – 4	2.5	1	⅓
5 – 8	5.0	2	⅔
9 – 14	10.0	4	1⅓
15 & Above	15.0	6	2

3.4.2 Treatment of P. falciparum malaria

Artemisinin Combination Therapy (ACT) should be given to all confirmed P. falciparum cases found positive by microscopy or RDT. This is to be accompanied by single dose primaquine (0.75 mg/kgbody weight) on Day 2. ACT consists of an artemisinin derivative combined with a long acting antimalarial (amodiaquine, lumefantrine, mefloquine or sulfadoxine-pyrimethamine). The ACT recommended in the national programme in India is artesunate + sulfadoxine-pyrimethamine (SP).Presently, fixed dose combinations of artemether + lumefantrine, artesunate + amodiaquine and blister pack of artesunate + mefloquine are registered for marketing in India and are available foruse. Other ACTs which will be registered and authorized for marketing in India may also be used as alternatives.

Oral artemisinin monotherapy is banned in India. Artemisinin derivatives must never be administered as monotherapy for uncomplicated malaria. These rapidly acting drugs, if used alone, can lead to development of drug resistance.

Dosage schedule of ACT for P.f cases:

Dte of NVBDCP Delhi has supplied ACT for use against all P.f cases. The drug is manufactured by Medicamen Biotech ltd. The strength of each tablet varies from the one mentioned in the national antimalaria drug policy 2013. Hence the following details are provided regarding the dosage schedule of ACT.

1) **Antimalarial Combi Blister pack for adult**:

   Strength of Artesunate tablets is 200 mg. (AS) (3 tablets) (Day 1: 1tab, Day 2: 1 tab Day 3: 1 tab)
   Strength of SP tablet is Sulfadoxine- 750 mg and Pyrimethamine 37.5 mg. (SP) (2 tablets)-(Day 1: 2 tabs)

2) **Antimalarial Combi Blister pack for 9 - 14 years**:

   Strength of Artesunate tablets 100 mg (3 tablets)+50 mg.(3 tablets)(AS) (Day 1: 1+1 tabs, Day2: 1+1 tabs, Day3: 1+1 tabs)
   Strength of SP tablet is Sulfadoxine- 500 mg and Pyrimethamine 25 mg. (SP) (2 tablets)- (Day 1: 2 tabs)

3) **Antimalarial Combi Blister pack for 5 - 8 years**:

   Strength of Artesunate tablets is 100 mg (AS) (3 tablets) (Day 1: 1 tab, Day 2: 1 tab, Day 3: 1 tab)
   Strength of SP tablet is Sulfadoxine- 750 mg and Pyrimethamine 37.5 mg. (SP) (1 tablet) (Day 1: 1 tab)

4) **Antimalarial Combi Blister pack for 1 - 4 years**:

   Strength of Artesunate tablets is 50 mg. (AS) (3 tablets) (Day 1: 1 tab, Day 2: 1 tab, Day 3: 1 tab)
   Strength of SP tablet is Sulfadoxine- 500 mg and Pyrimethamine 25 mg. (SP) (1 tablet) (Day 1: 1 tab)

5) **Antimalarial Combi Blister pack for infants less than 1 year**:

   Strength of Artesunate tablets is 25 mg. (AS) (3 tablets) (Day 1: 1 tab, Day 2: 1 tab, Day 3: 1 tab)
   Strength of SP tablet is Sulfadoxine- 250 mg and Pyrimethamine12.5 mg. (SP) (1 tablet) (Day 1: 1 tab)

Dosage for all ages:		Artesunate: 4 mg / kg body weight; SP tablet: 25 mg / kg body weight		
Age		**1st Day (number of tabs)**	**2nd Day (number of tabs)**	**3rd Day (numbers of tabs)**
<1 Year	AS (25mg) SP (250mg/12.5mg)	1 1	1 Nil	1 Nil
1-4 Yeas	AS (50mg) SP (500mg/25mg)	1 1	1 Nil	1 Nil
5-8 Year	AS (100mg) SP (750mg/37.5mg)	1 1	1 Nil	1 Nil
9-14 Year	AS (100mg+50mg) SP (500mg/25mg)	1+1 2	1+1 Nil	1+1 Nil
15 and above	AS (200mg) SP (750mg/37.5mg)	1 2	1 Nil	1 Nil

A single dose of Primaquine i.e. 0.75 mg/kg body weight, is recommended to be given with ACT combination as it will enhance gametocyte clearance and facilitate interruption of transmission. Primaquine should also be not used in pregnant women and infants. As per current national policy,Artemisinin derivatives are not to be used in pregnant women during the first trimester.

Primaquine Dosage for *Plasmodium falciparum* cases

Age in years	Dosage on Day 3 only (Single dose only)		
	Dosage (in mg of base)	No. of Tablets (2.5 mg base)	No. of Tablets (7.5 mg base)
< 1	Nil		0
1 – 4	7.5	3	1
5 – 8	15	6	2
9 – 14	30	12	4
15 & above	45	18	6

If RDK for only Pf is used, negative cases showing signs and symptoms of malaria without any other obvious causes should be considered as 'clinical malaria' and treated with chloroquine in full therapeutic dose of 25 mg/kg body weight over three days. Similarly, in situations where diagnosis by microscopy or RDK is not possible, cases showing signs and symptoms of malaria without any other obvious causes should be considered as 'clinical malaria' and treated with chloroquine in full therapeutic dose of 25 mg/kg body weight over three days in low risk area while in high risk area a single dose of Primaquine 0.75 mg/kg bw should also be given on the first day. This practice is to be followed at all levels including VHWs like FTDs/ASHA as well.

3.5 Treatment of malaria in pregnancy

ACT should be given for treatment of P. falciparum malaria in second and third trimesters of pregnancy, while quinine is recommended in the first trimester. Quinine 600 mg tablet (10 mg/kg body weight) is to be given 3 times a day for 7 days. P. vivax malaria has to be treated with chloroquine.

3.6 Treatment of mixed infections

Mixed infections with P. falciparum should be treated as falciparum malaria with ACT. In addition primaquine is also given for 14 days.

3.7 Treatment based on clinical criteria without laboratory confirmation

All efforts should be made to diagnose malaria either by microscopy or RDT. However, special circumstances should be addressed as mentioned below:

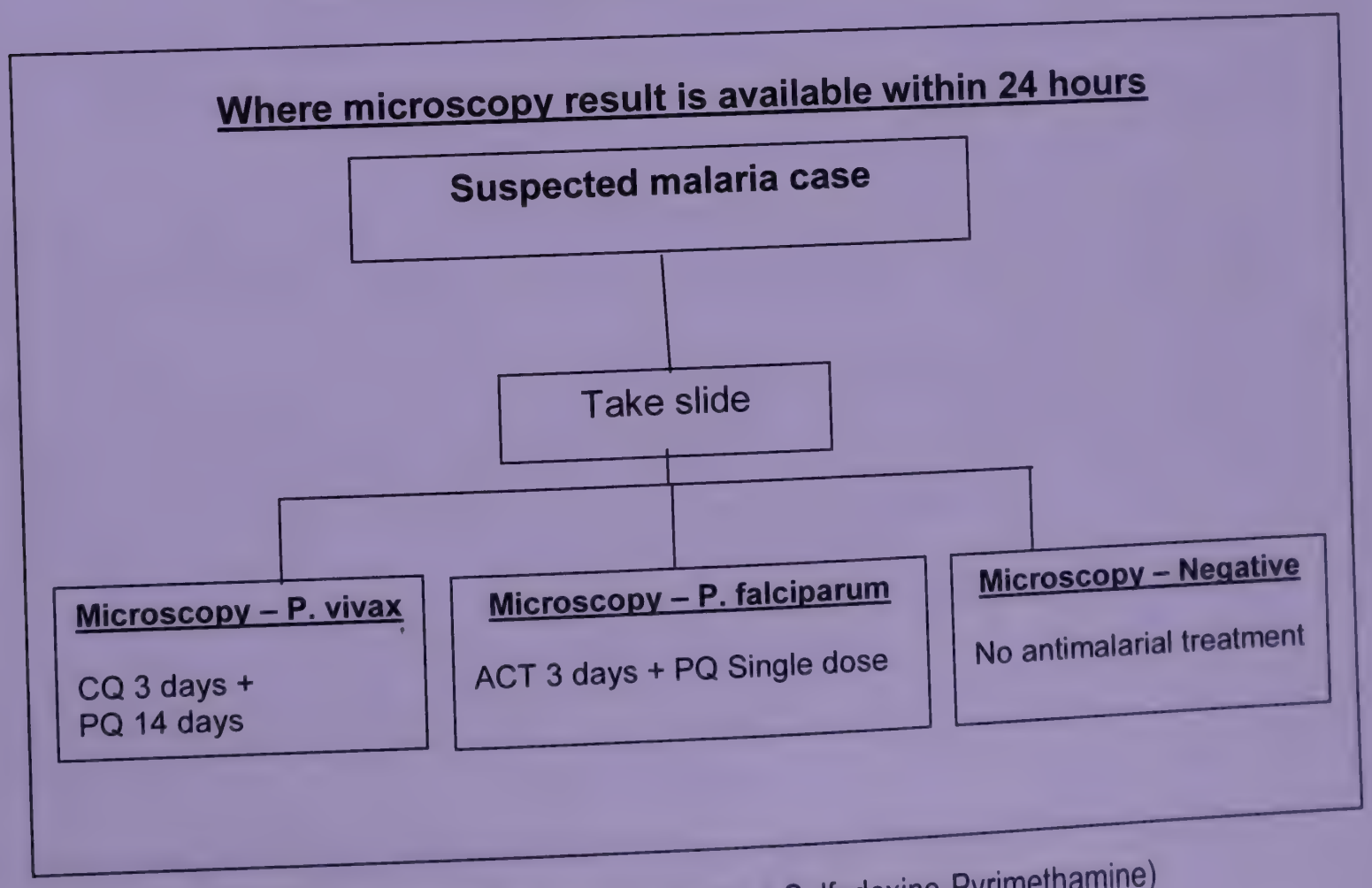
- If RDT for only P. falciparum is used, negative cases showing signs and symptoms of malaria without any other obvious cause for fever should be considered as 'clinical malaria' and treated with chloroquine in full therapeutic dose of 25 mg/kg body weight over three days. If a slide result is obtained later, the treatment should be completed according to species.
- Suspected malaria cases not confirmed by RDT or microscopy should be treated with chloroquine in full therapeutic dose.

3.8 General recommendations for the management of uncomplicated malaria

- Avoid starting treatment on an empty stomach. The first dose should be given under observation.
- Dose should be repeated if vomiting occurs within 30 minutes.
- The patient should be asked to report back, if there is no improvement after 48 hours or if the situation deteriorates.
- The patient should also be examined for concomitant illnesses.

The algorithm for diagnosis and treatment is shown below.

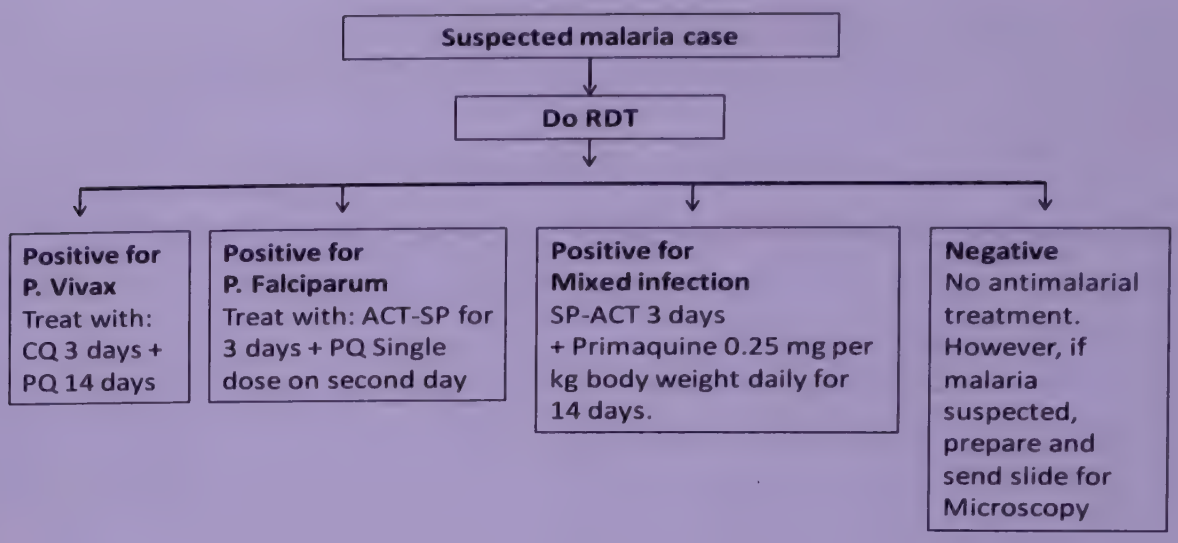
Figure: Fever Diagnosis and Treatment Algorithm


Where microscopy result is available within 24 hours
Suspected malaria case
Take slide
Microscopy – P. vivax
CQ 3 days +
PQ 14 days
Microscopy – P. falciparum
ACT 3 days + PQ Single dose
Microscopy – Negative
No antimalarial treatment

ACT - Artemisinin-based Combination Therapy (Artesunate + Sulfadoxine-Pyrimethamine)

CQ -Chloroquine **PQ**– Primamaquine.

Where microscopy result is not likely to be available within 24 hours and Bivalent RDT is used


Suspected malaria case
Do RDT
Positive for P. Vivax Treat with: CQ 3 days + PQ 14 days
Positive for P. Falciparum Treat with: ACT-SP for 3 days + PQ Single dose on second day
Positive for Mixed infection SP-ACT 3 days + Primaquine 0.25 mg per kg body weight daily for 14 days.
Negative No antimalarial treatment. However, if malaria suspected, prepare and send slide for Microscopy

Where microscopy result is not expected to be available is 24 hrs and RDT's are also not available: For all suspected malaria cases, prepare blood smear for microscopy and give chloroquine for 3 days. After the blood smear is examined, the positive cases are to be radically treated appropriately. The P.f cases are to be given ACT and primaquine.

3.9 Treatment failure/Drug resistance

After treatment patient is considered cured if he/she does not have fever or parasitaemia till Day 28. Some patients may not respond to treatment which may be due to drug resistance or treatment failure, especially in falciparum malaria. If patient does not respond and presents with following, he/she should be given alternative treatment.

Early treatment failure (ETF): Development of danger signs or severe malaria on Day 1, 2 or 3, in the presence of parasitaemia; parasitaemia on Day 2 higher than on Day 0, irrespective of axillary temperature; parasitaemia on Day 3 with axillary temperature37.5°C; and parasitaemia on Day 3 with 25% of count on Day 0.

Late clinical failure (LCF): Development of danger signs or severe malaria in the presence of parasitaemia on any day between Day 4 and Day 28 (Day 42) in patients who did not previously meet any of the criteria of early treatment failure; and presence of parasitaemia on any day between Day 4 and Day 28 (Day 42) with axillary temperature 37.5°C in patients who did not previously meet any of the criteria of early treatment failure.

Late parasitological failure (LPF): Presence of parasitaemia on any day between Day 7 and Day 28 with axillary temperature <37.5°C in patients who did not previously meet any of the criteria of early treatment failure or late clinical failure. Such cases of falciparum malaria should be given alternative ACT or quinine with Doxycycline. Doxycycline is contraindicated in pregnancy, lactation and in children up to 8 years. Treatment failure with chloroquine in P. vivax malaria is rare in India.

3.10.Severe and complicated malaria cases

Serious complications can arise in *P.falciparum* infection. They may sometimes develop suddenly over a span of time as short as 12 -24 hours and may lead to death, if not treated promptly and adequately. Severe malaria is clinically characterized by confusion or drowsiness with extreme weakness (prostration). In addition, the patient may develop cerebral malaria with generalized convulsions, pulmonary oedema, severe anaemia, renal failure, hypoglycaemia, metabolic acidosis, circulatory collapse/shock, spontaneous bleeding and laboratory evidence of DIC, macroscopic haemoglobinuria, hyperthermia or hyperparasitaemia.

In children, febrile convulsions, repeated vomiting and dehydration are common if the temperature is high, therefore a diagnosis of malaria should be confirmed at the earliest.

In pregnancy, malaria, especially *P.falciparum* is a serious disease because with each bout of malaria, there is a reduction in haemoglobin and profound anemia may develop rapidly. They are also at high risk of abortions or intrauterine growth retardation because sequestration of parasites in placenta restricts oxygen and nutrients flow to the fetus.

Requirements for management of complications

For management of severe malaria, health facilities should be equipped with the following:

- Parenteral antimalarials , antibiotics, anticonvulsants, antipyretics
- Intravenous infusion equipment and fluids
- Special nursing for patients in coma
- Facilities for blood transfusion
- Well-equipped laboratory
- Oxygen respirator

If these items are not available, the patient must be referred without delay to other institutions where such facilities are available. A list of all health care facilities in the district where emergency care for severe malaria is available should be kept available with private health providers.

Note: Before referring patients, please conduct RDT and take blood smear, give a parenteral dose of Quinine or artemisinin derivatives in suspected cerebral/complicated malaria cases and send case sheet, details of treatment history and blood slide with patient.

Management of severe malaria cases

Severe malaria is an emergency and treatment should be given as per severity and associated complications which can be best decided by the treating physicians. Parenteral artemisinin derivatives or quinine should be used irrespective of chloroquine resistance status of the area. However, the guidelines for specific antimalarials therapy as per the WHO recommendation are given below:

- **Quinine salt** 20 mg/kg* body weight (bw) on admission (IV infusion or divided IM injection) followed by maintenance dose of 10 mg/kg bw 8 hourly; infusion rate should not exceed 5 mg salt / kg bw per hour.

  (*loading dose of Quinine salt i.e 20mg /kg bw on admission may not be given if the patient has already received quinine or if the clinician feels inappropriate).

- **Artesunate:** 2.4 mg/kg bwi.v. or i.m. given on admission (time=0), then at 12 h and 24 h, then once a day for 2 days.

- **Artemether:** 3.2 mg/kg bwi.m. given on admission then 1.6 mg/kg bw per day for 2 days.

- **Arteether:**150 mg daily i.m for 3 days in adults only (not recommended for children).

Note:

A. The parenteral treatment should be given for minimum of 48 hours and oncethe patient tolerates oral therapy, quinine 10 mg/kg bw three times a day with doxycycline 100 mg once a day or clindamycin in pregnant women and children under 8 years of age, should be given to complete 7 days of treatment in patients treated with parenteral quinine.

B. Full course of ACT should be administered to patients treated with artemisinin derivatives.

C. Use of mefloquine alone or in combination with artesunate should be avoided especially in cerebral malaria due to neuropsychiatric complications associated with it.

D. In severe and complicated *P.falciparum* malaria cases intravenous Quinine/ parenteral Artemisinine derivatives are to be given irrespective of chloroquine resistance status. This treatment may continue till such time oral Quinine/Artemesinin derivatives become available.

Role of ASHA/Volunteer in handling severe malaria cases

The peripheral workers should be well conversant with the signs and symptoms of malaria and also its serious complications. When the patient without complications comes to any of the most peripheral agencies (ASHA, MPHW), they should invariably instruct the patient that if he/she does not get relief within a reasonable period of time i.e. 48 hours and/or headache/fever continues to increase, the patient should report to nearest PHC/CHC/hospital. The ASHA/volunteer will be trained to detect signs of severe malaria.

Criteria for referral as a case of severe malaria

- Persistence of fever after 48 hours of initial treatment.
- Continuous vomiting and inability to retain oral drugs.
- Headache continues to increase.
- Severe dehydration-dry, parched skin, sunken face.
- Too weak to walk in the absence of any other obvious reason.
- Change in sensorium e.g., confusion, drowsiness, blurring of vision, photophobia, disorientation.
- Convulsions or muscle twitchings.
- Bleeding and clotting disorders.
- Suspicion of severe anaemia.
- Jaundice.
- Hypothemia.

Pre-identification of referral centres:

Every volunteer / health worker should know as to which is the hospital to which a case of severe malaria should be referred as this is so very important to ensure that the patients do not waste time by going to the wrong places. The information is given by the MO-PHC / DVBDCO and the choice of referral centre would be based on the quality of care available for severe malaria as well as the availability of round-the-clock emergency services. The sentinel sites which are being identified will also the right choices to serve as the referral centres. The referral institutions may be public or private, but at least one public institution will be identified in each district where free services are available.

Essential facilities in PHC:

Every PHC must provide at least adequate immediate care to all patients of severe malaria before higher referral for which the following facilities should be available at the PHC:

- Blood smear examination and parasite count.
- RDT
- Routine exam of urine and haemoglobin estimation.
- Oral antimalarial drugs including ACT
- Injectable Quinine, injectable artemsinin preparation

- Saline / glucose / dextrose for intravenous transfusion.
- Oxygen for serious and complicated cases.
- Antipyretics, anticonvulsants, diuretics, antibiotics.

Essential facilities at referral hospital
The following facilities should be available at the referral centre to which severe malaria cases are referred:

- Specialized biochemical, radiological and microbiological tests
- Intensive care management and round-the-clock monitoring to deal with the critical illness
- Ventilatory support, particularly volume ventilator
- Blood transfusion
- Peritoneal dialysis

The PHC medical officer will send the case-sheet along with the patient, also indicating antimalarials administered, dosage and time of administration, reports of blood smears and other investigations for guidance to the second referral level. The staff in the PHC should explain to the patient's attendants the need for referral to a higher facility. There may be some patients/attendants who are reluctant for transfer. In such cases, the problems should be identified and the concerns and worries overcome.

3.11 Chemoprophylaxis

Chemoprophylaxis should be administered only in selective groups in high *P.falciparum* endemic areas. Use of personal protection measures including insecticide treated bed nets should be encouraged for pregnant women and other vulnerable population including travelers for longer stay. However for longer stay in high Pf endemic districts by the Military & Para-military forces, the practice of chemoprophylaxis should be followed wherever appropriate e.g. troops on night patrol duty etc. and decisions of their Medical Administration Authority should be followed.

For short term chemoprophylaxis (less than 6 weeks), daily doxycycline is the drug of choice (if not contraindicated). It should be given daily in the dose of 100 mg in adults and 1.5 mg/kg for children (if not contraindicated). The drug should be started 2 days before travel and continued for 4 weeks after leaving the malarious area. However, it is not recommended for pregnant women and children less than 8 years. Mefloquine is the drug of choice for chemoprophylaxis involving longer stay. It is contraindicated in cases with history of convulsions, neuropsychiatric problems and cardiac diseases. Hence, necessary precautions should be taken and all should undergo screening before prescription of the drug.

For long term chemoprophylaxis (more than 6 weeks), Mefloquine 250 mg weekly is administered two weeks before, during and four weeks after exposure. Mefloquine is contraindicated in cases with history of convulsions, neuropsychiatric problems and cardiac conditions. Hence, necessary precautions should be taken.

4. Malaria Control Strategies

The three pronged strategy for prevention and control of malaria includes:

1. Early Diagnosis and Complete Treatment (EDCT)
    a. Case detection & management
    b. Disease surveillance
    c. Epidemic preparedness

2. Integrated Vector Control
    a. Indoor Residual Spray (IRS)
    b. Insecticide treated bednets (ITNs) & Long Lasting Insecticide Treated Nets (LLINs)
    c. Biological control (introduction of larvivorus fish in perennial breeding sources)
    d. Source reduction by environmental modification & manipulation

3. Supportive interventions
    a. Training &capacity Building
    b. Behavioural Change Communication
    c. Inter sectoral collaboration
    d. Community participation
    d. Public Private Partnership (eg. NGO/ CBOs/ IMA etc.)
    e. Monitoring, Evaluation & Supportive supervision
    f. Legislation

The strategy of prevention and control of malaria is explained below:

4.1 Early Diagnosis and Complete Treatment

4.1.1 Case detection and management have already been discussed in the earlier chapter.

4.1.2 Disease surveillance

Surveillance is defined as the ongoing and systematic collection, analysis, interpretation, and dissemination of data about cases of a disease and is used as a basis for planning, implementing, and evaluating disease prevention and control activities.

Passive surveillance implies the detection of malaria cases from those fever cases that visit the health facilities (PHCs /CHCs/ Hospitals) and are tested for malaria through slide microscopy. **Active surveillance** implies that the MPW (M) would visit all villages within the subcentre area weekly / fortnightly and look for fever cases. At the village level ASHA or other volunteer have to be trained and deployed for providing early diagnosis and effective treatment by screening fever cases by blood smear / RDT.

Active surveillance is the prime responsibility of the Jr. Health Assistants. He or she has to conduct domiciliary house-to-house visit at least fortnightly (in case of Male Jr. Health Assistants) and weekly in case of female Jr. Health Assistants, as per schedule developed by Medical Officer in-charge of PHC. They have to look for fever cases as on the day of the visit, fever cases which have occurred since their previous visit, movement history of fever cases. They are to collect blood smears (thick and thin) (or perform Rapid

Diagnostic Test as the case may be) for fever cases. Slide is transported along with filled in M-2 forms to Lab for examination to the PHC.

No presumptive treatment: Traditionally the MPW was expected to collect blood smears from all fever cases and give a single dose of chloroquine as presumptive treatment.

> In the programme presumptive treatment used to be given to all fever cases with a single dose of chloroquine. This practice has been withdrawn. However the blood smears will continue to be taken. All suspected malaria cases (as per given definition) would be treated with 3 days of chloroquine.

> It may be noted that Rapid Diagnostic Kits are being supplied in selected/identified areas only and in few numbers only. Therefore slide collection from fever cases is very important. Even when RDT is done, slide has to be collected simultaneously from that fever case because RDT test is only for P.f. Please refer to the Diagnosis and Treatment Algorithm provided in the earlier pages.

Radical treatment: On examination of blood smears, the positive cases are to be given radical treatment as mentioned earlier.

Follow up of malaria cases: All the positive cases – especially Pf cases - are to be followed up to confirm whether they have responded to treatment. Persistence of fever or other symptoms, worsening of symptoms is observed for (clinical follow up). A blood smear is also taken at the earliest between 3 to 7 days of initiating RT. Such a blood smear is examined on priority and any persistence of parasites in the smear (especially with ring stages or ring and gametocyte stages of Pf infection) is given repeat or other appropriate treatment, as recommended in the national drug policy. The matter is also to be informed to DVBDCOso that further studies are conducted by the authorized experts.

Since presumptive treatment is withdrawn, guidelines are issued to identify a suspected case of malaria among the fever cases based on a particular case definition and to treat these cases with full dose of chloroquine.

Suspected case of malaria (case definition):
The definition of suspected malaria is "a patient with fever in endemic area during transmission season, or who has recently visited an endemic area without any other obvious cause and in the absence of a confirmed diagnosis". For ruling out other causes of fever, the following should be looked for.

1. Cough and other signs of respiratory infection
2. Running nose and other signs of cold
3. Diarrhoea
4. Pelvic inflammation
5. Skin rash suggestive of eruptive illness
6. Burning micturition
7. Skin infections e.g. boils, abscess, infected wounds
8. Painful swelling of joints
9. Ear discharge

However, none of these symptoms exclude malaria with certainty. In the programme, Jr. Health Assistants are also to be trained to rule out malaria based on these "other causes", but it is to be assessed as to how well these definitions are practically used at the grass root level. Under the new strategy, ASHA/ community

volunteer will be the primary care provider, with minimal skills. They will be initially trained to perform a blood test on every case of fever. This may result in an overuse of blood tests initially. Over a period of time, they will be taught to be more discriminating in differentiating "suspected malaria cases from "all fever cases" and the number of blood tests carried out by them is likely to reduce proportionately.

Rapid Fever Surveillance (RFS): When an outbreak of malaria is detected in an area, fever survey of the affected population is carried out a daily basis till the outbreak is brought under control. Blood smears are examined on the same day or at the earliest in the field laboratory set up there or at the PHC. Radical treatment is given to positive cases at the earliest. The objective is to conduct intense surveillance and treat positive cases as soon as possible. RFS is also done in a village when it is suspected that the area MPW is not doing quality surveillance so that the true situation can be assessed.

Mass survey: Here the entire village is covered by taking a blood smear from everybody available irrespective of presence of fever. The objective is to assess the magnitude of parasite prevalence even among asymptomatic cases.

Contact survey: Blood smears are taken from contacts of a positive case especially P.f. The objective is to assess any possible spread of infection among the contacts.

Fever Treatment Depots (FTD): At the village level a person is identified who can take blood smear from a fever case and give presumptive treatment. This is done so that, in between the visits of regular health staff, facility of surveillance is available round the clock in the village. ASHA is expected to perform the FTD function.

Drug distribution centers (DDC): When the village level volunteer is unable to take blood smear he was asked to provide presumptive treatment to fever cases. Instructions have been given to convert all the DDCs to FTD.

4.1.3 Epidemic preparedness; Outbreak detection and response

An epidemic is defined as the occurrence of a disease of similar nature in the community clearly in excess of normal expectancy. The term 'outbreak' is usually used for a small, localized epidemic when the number of cases is not very large.

Key factors to be monitored for prediction and early detection of malaria outbreaks include the changes in fever pattern among the outpatients, significant number of malaria positives in passive surveillance compared to very low or nil cases in active surveillance, occurrence of more P.f cases, early and heavy rainfall in pre-transmission period, influx of migrants from non-endemic to endemic areas and vice-versa, aggregation of labour in projects, population migration during floods and drought etc.

The medical officer should analyze the weekly reports of Form S from subcenters to identify increase of fever cases. M 3, MF 8 and MF 9 should be analyzed weekly for the same purpose. Increase of fever cases in OPD, clustering of cases in villages / subcenters, and rise in malaria positivity rate in the laboratory examination may also be noted. Interaction with the MPWs would also indicate situation of fever cases. Rising fever incidence may also be reported by ASHA / FTD holder, medical practitioners of the area, NGO, community leaders / members, press and panchayats.

Investigation and control of outbreak:

Fever outbreak is an emergency and investigation should be carried out without any delay. The DVBDCO /DSO/DHO should be informed immediately. He would be a member of the rapid response team.

Field investigations includerapid fever survey among all the households in the affected area. It may be necessary to set up a clinic and a laboratory in the affected village. Blood smears are to be examined same day and positive cases should be adequately treated. All persons whose blood smear has been taken for microscopy should be given clinical treatment with 3 day course of chloroquine; appropriate, complete treatment will be given to all those persons who test positive. All age groups should be covered, especially children, pregnant women and migrants. The rapid fever survey should be done daily and continued till such time no fever cases occur for at least 10 days. It is necessary to investigate cause of epidemic by an epidemiological investigation to find out any possible breakdown of regular malaria control operations, influx of migratory population which was not covered by routine control measures

Emergency anti-vector measure is the space spray with pyrethrum. Space survey should be started as soon as survey results of a village are available. Other villages are included as soon as their survey results are available. Every house in the epidemic villages should be covered. Formulation of pyrethrum is 1 litre of 2% Pyrethrum extract diluted with 19 litres of kerosene oil(or any other formulation readily available like Finit, Hexit or Baygon etc.). The dosage is 15 to 30 cc to be sprayed in 30 cubic meters of space. Hand operated micro-discharge fogging machine/atomizers (Flit gun) can be used. It should be done preferably early morning or late evening hours after closing all doors and windows and other openings before space spray.

The indoor residual insecticidal spray should be started simultaneously with indoor space spray. The insecticide of choice will be the insecticide to which the local vector is amenable to control. Apply the recommended close of insecticide chosen to all human an mixed dwellings

If the epidemic is due to predominance of vector breeding in water storage tanks or in peri-domestic water collections, undertake anti-larval measures alongwith space spray and residual spray. Detailed entomological investigation may be carried out later to ascertain the susceptibility status of the vector(s).

4.2. Integrated Vector Control

4.2.1 Indoor residual spraying:

Adulticidal measures (for adult mosquitoes) include 1) Indoor Residual Spray (IRS), 2) Space Spray and Fogging operations and 3) Personal Protection Measures.

Vector control programmes mostly rely on usage of natural and synthetic chemical molecules, which have potential to kill the target insects. Presently different formulations of synthetic chemical insecticides are in use for IRS. Wettable powder (WP) formulations are used for indoor residual sprays while emulsion concentrate (EC) formulations are used for larval control. For Indoor Residual Spray (IRS) insecticides in use are DDT 50% WP, Malathion 25% WP and Synthetic Pyrethroid (WP). Synthetic Pyrethroids include Deltamethrin 2.5% WP, Cyfluthrin 10% WP, Lambdacyhalothrin 10% WP, alphacypermethrin 5% WP and Bifenthrin 10% WP. Synthetic Pyrethroid insecticides are also used for impregnation of bednets.

Most of the insecticides having residual effect are sprayed indoors, so that mosquitoes after having bite on an infective person will rest in the house and will pick up sufficient insecticide particles sprayed on the walls and other indoor surfaces of the house and its longevity will be reduced so much so that it does not survive to become infective. In areas where the vectors are strongly endophilic, i.e. they tend to rest indoors, indoor residual spraying of human dwellings can give very effective control. Vectors that are exophillic i.e. they tend to rest outdoor but tend to feed or rest indoors briefly, can be effectively controlled by indoor residual spraying with insecticides that have good airborne effect. In areas where vectors are strongly exophillic and/or exophagic,

i.e. they rest and bite outdoors, other control methods, such as use of insecticide treated mosquito nets or exterior space spraying (for emergency control), should be considered.

In practice, the effectiveness of house spraying for malaria control depends on adherence to the specified criteria of the insecticide and application procedure, public acceptance of spraying, the availability of well-maintained equipment, adequately trained spraying persona depends on local circumstances and is influenced by the distribution of malaria and malaria vectors; distance from important breeding sites, the flight range of the vectors and demographic features. Timing of IRS is essential and must be based on epidemiological and transmission dynamics data. In general, spray operations should take place approximately one month before the start of the potential seasonal increase in incidence. The peak transmission season(s) are usually determined by rainfall.

A systematic effort is needed to improve the quality of IRS. People's perception of IRS should be changed through dialogue and flexible communication methods instead of enforcement. Safe insecticide management practices must be incorporated in all chemical vector control operations. Systematic, supportive supervision should be based on standard operating procedures. The antiquated stirrup pumps should be replaced by the more reliable and less contaminating compression sprayers as soon as possible.

4.2.1.1. Selection of Insecticides, calculation of required quantities and safety precautions:

Selection of Insecticide:

IRS will only be effective if the target vectors are susceptible to the insecticide in use. The development of resistance to insecticides constitutes a major threat to the chemical control of malaria vectors, as it compromises the insecticide's efficacy. A comprehensive assessment of resistance at the local level must be carried out before planning any IRS programme. The possibility of insecticide resistance calls for the careful monitoring of the susceptibility of malaria vectors to insecticides, and the sound management of resistance.The commonly used insecticides are DDT, Malathion and different formulations of synthetic pyrethroids.

DDT (Dichloro-diphenyl-trichloro ethane) – Organo-chlorine compound:

It is comparatively cheaper than the other insecticides and even in those areas where resistance to DDT has been recorded in studies with WHO test kits, the epidemiological impact of good spray operations is seen because of its excito-repellent action. 150 MT per million population for two rounds of spray is required. In areas where third round is proposed in selected villages, additional requirement of 75 MT per million population should be estimated.

Organo-phosphorous compounds:

Malathion 25% WP is used under the programme in areas with DDT resistance. The disadvantage of organo-phosphorous compounds is that unlike their use in agriculture where a farmer uses the organo-phosphorous compound for crop protection only once or twice a year, the spray squads engaged in spraying residual insecticide in the human dwellings work with these compounds for periods extending upto 6 or 7 months. This long exposure results in acute toxic symptoms and if not controlled properly may lead to mortality. Therefore, the spray staff engaged in spraying of organo-phosphorous compound is to be provided with more elaborate protective garments and their blood cholinesterase level is to be checked periodically to assess the toxic impact of the compound. These compounds are also toxic to domestic pets.

Under Indian conditions, three rounds of spray with organo-phosphorous compounds are given as against two rounds of spray with DDT. 900 MT per million population for three rounds of spray are required. If in some

areas a further round is required in selected villages, 300 MT per million population for the special round for the population of selected villages only.

Synthetic Pyrethroids:

These are new insecticides introduced for control of vector borne diseases in India. The cost of these insecticides is much higher than the cost of DDT and Malathion. Currently there are five insecticides of this group registered with Central Insecticide Board for use in the programme. These are (i) Deltamethrin 2.5% WP (ii) Cyfluthrin 10% WP, (iii) Alphacypermethrin 5% WP (iv) Lambdacyhalothrin 10% WP and (v) Bifenthrin 10%WP.

Requirement of Synthetic Pyrethroids:

(i) Deltamethrin 2.5% WP: 60 MT per million population for two rounds of spray. In some areas, where a further round is required in selected villages, additional requirement of 30 MT per Million for the population of selected villages is estimated.

(ii) Cyfluthrin 10% WP: 18.75 MT per million population for two rounds of spray and 9.38 MT per million population for selected villages which would require special round/third round of spray.

(iii) Lambdacyhalothrin 10% WP: 18.75 MT per million population for two rounds of spray and for a special round or IIIrd round of spray in selected villages, 9.38 MT per million population may be estimated.

(iv) Alphacypermethrin 5% WP 37.5 MT per million population for two rounds of spray.

(v) Bifenthrin 10% WP: 18.75 per million population for two rounds of spray and 9.38 MT per million population for selected villages which would require special round/third round of spray.

Insecticide formulations and dosages for IRS:

S.No.	Name of insecticide	Preparation of suspension in water	Dosage per sq.metre of active ingredient	Residual effect in weeks	Area to be covered by 10 lit. of suspension to get correct dosage
1.	DDT 50% WP	1 kg./10 lit.	1 gm.	10-12	500 sq.m.
2.	Malathion 25 % WP	2 kg./10 Lit.	2 gm.	6-8	250sq.m.
3.	Deltamethrin 2.5% WP	400 gm/10 Lit.	20 mg.	10-12	500 sq.m.
4.	Cyfluthrin 10% WP	125 gm./10 Lit.	25 mg.	10-12	500 sq.m.
5.	Lambdacyhalothrin 10% WP	125 gm.10 Lit.	25 mg.	10-12	500 sq.m.
6.	Alphacypermethrin 5% WP	250 gm/10 Lit.	25 mg.	10-12	500 sq.m.
7.	Bifenthrin 10% WP	125g/10 lit.	25 mg.	10-12	500 sq.m.

* In the case of Malathion, the requirement shown above, is for the three rounds

Calculation of Active Ingredient (AI):

1) DDT 50% wdp: 1 Kg + 10 Lts Water = 500 Sq. Mts. 1 Kg of 50% DDT contains 500 gms A.I. 500gms A.I. covers 500 Sq. Mts. Therefore, deposit for 1 Sq. Mt is 1gm.

2) Malathion 25% wdp: 2 Kgs + 10 Lts Water = 250 Sq. Mts. 1 Kg of 25% Malathion contains 250 gms A.I. So, 2 Kgs contain 500 gms of A.I. 500gms A.I. covers 250 Sq. Mts. Therefore, deposit for 1 Sq. Mt is 2 gms.

3) Deltamethrin 2.5% wp: 400 gms + 10 Lts Water = 500 Sq. Mts. 100 gms of DMT contains 2.5 gms A.I. 400gms Contains 10 gms of A.I. 10 gm = 10,000 mg. 10,000 mg covers 500 Sq. Mts. Therefore, deposit for 1 Sq. Mt is 20 mg.

4) Alphacypermethrin 5% wp. 250 gms + 10 Lts Water = 500 Sq. Mts. 100 gms of ACM contains 5 gms A.I. 250gms Contains 12.5 gms of A.I. 12.5 gm = 12,500 mg. 12,500 mg covers 500 Sq. Mts. Therefore, deposit for 1 Sq. Mt is 25 mg.

5) Synthetic Pyrethroid 10% wp. (LMD,CYF,BIF 10%): 125 gms + 10 Lts Water = 500 Sq. Mts. 100 gms of SP 10% contains 10 gms A.I. 125gms Contains 12.5 gms of A.I. 12.5 gm = 12,500 mg. 12,500 mg covers 500 Sq. Mts. Therefore, deposit for 1 Sq. Mt is 25 mg.

4.2.1.2 Safety precautions for IRS and insecticide management

Exposure to insecticides may occur when handling the insecticide product during opening of the package, mixing and preparation of the spray or when spraying the insecticide, especially in high places, the operator should wear a protective hat and face-shield or goggles. He should not eat, drink or smoke while working. He should wash hands and face with soap and water after spraying and before eating, smoking or drinking. He should shower or bathe at the end of every day's work and change into clean clothes. He should wash overalls and other protective clothing at the end of every working day in soap and water and keep them separate from the rest of the family's clothes. If the insecticide touches his skin, it should be washed off immediately with soap and water. Clothes should be changed immediately if they become contaminated with insecticides. Supervisor should be informed immediately if he feels unwell.

The removal or physical protection of all foodstuffs and cooking or eating utensils is imperative. In addition, inhabitants should be advised not to enter a sprayed room until the spray is dry, and to sweep all floors before allowing free entry into the house. This is particularly important for families with small children or indoor domestic animals that may have greater contact with the floor.

The use of protective devices and safe working practices is essential to avoid or reduce the contamination of spraymen, packers and mixers with the insecticide. In most spraying programmes in which insecticides of low acute toxicity (such as DDT) have been used, it is sufficient to wear overalls, broad-brimmed hats to cover the neck of the overalls, gloves and shoes or boots (the openings of which should be covered by the long trousers of the overalls). More toxic or more irritating insecticides require more elaborate protective devices such as light masks, goggles, visors and respirators.

Packers and mixers have a higher risk of contamination and should therefore use rubber gloves, masks or respirators and protect their eyes with a visor made of transparent plastic attached to the hat. Squad leaders must enforce safe practises and the appropriate use of protective devices. They must be familiar with early signs of intoxication and monitor members of their squad for any sign of poisoning.
Basic precautions to prevent unnecessary contamination include:

- Hands and face should be washed after filling each pump charge.

- Eating, drinking and smoking should be forbidden, except after washing and before starting to spray.
- Spraymen should not be exposed to insecticide for more than six hours each day.
- Overalls and hats should be washed daily, especially if they have been heavily contaminated.
- Spraymen must take a shower at the end of each day's work.

Empty insecticide containers must be collected by the team supervisors and brought to the central storage area for proper disposal by qualified staff. It is also essential to follow the recommendations for the disposal of larger metal containers. Reuse of containers is always dangerous.

Disposal of remains of insecticides and empty packaging

At the end of the day's work, the inside of the sprayer should be washed and any residual insecticide flushed from the lance and nozzle. The rinsing water should be collected and carefully contained in clearly marked drums with a tightly fitting lid. This should be used to dilute the next day's tank loads or disposed properly by the supervisor.

Never pour the remaining insecticide into rivers, pools or drinking-water sources. Decontaminate containers where possible. For glass, plastic or metal containers this can be achieved by triple-rinsing, i.e. part-filling the empty container with water three times and emptying into a bucket or sprayer for the next application. All empty packaging should be returned to the supervisor for SAFE disposal according to national guidelines. Never re-use empty insecticide containers.

In case of OP poisoning, the patient should be transported as soon as possible to a doctor to receive an **antidote**. 2-4 mg or atropine should be given intravenously (for children 0.5 to 2 mg according to weight). Depending on symptoms, further doses of 2 mg. should be given every 15 minutes for 2-12 hours. Automatic injections are available for administration of atropine. Pralidoxime injection can be used.

In treating pyrethroid poisoning vitamin E oil preparations can be given for prolonged paraesthesia. Only in cases of definite allergic symptoms should corticosteroids be administered. On concurrence of convulsions after sever intoxication, intravenous injection of 5-10 mg Diazepam (or other benzdiazepine derivatives) should be given.

Storage and transport:

Pesticide storage must be located away from areas where people or animals are housed and away from water sources, wells, and canals. They should be located on high ground and fenced, with access only for authorized persons. However, there should be easy access for pesticide delivery vehicles and – ideally – access on at least three sides of the building for fire-fighting vehicles and equipment in case of emergency. Pesticides must not be kept where they would be exposed to sunlight, water, or moisture, which could affect their stability.

Storehouses should be secure and well ventilated. Stocks should be arranged so that the oldest are used first ("first in first out" or, better, "first to be expired first out" principle), to avoid the accumulation of obsolete stock. Containers should be arranged to minimize handling and thus avoid mechanical damage which could give rise to leaks. Containers and cartons should be stacked safely, with the height of stacks limited to ensure stability.

Pesticides should not be transported in the same vehicle as items such as agricultural produce, food, clothing, drugs, toys, and cosmetics that could become hazardous if contaminated. Pesticide containers should be loaded in such a way that they will not be damaged during transport, their labels will not be rubbed off, and they will not shift and fall off the transport vehicle onto rough road surfaces. Vehicles transporting pesticides should carry prominently displayed warning notices. Pesticides should not be carried in the passenger compartments

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of transport vehicles and should be kept tightly secured and covered at all times during transport. The pesticide load should be checked at intervals during transportation, and any leaks, spills, or other contamination should be cleaned up immediately using accepted standard procedures. In the event of leakage while the transport vehicle is moving, the vehicle should be brought to a halt immediately so that the leak can be stopped and the leaked product cleaned up. Containers should be inspected upon arrival at the receiving station. There should be official reports to the national level and follow-up enquiries in the event of fires, spills, poisonings, and other hazardous events.

Distribution of pesticides should be carried out by trained personnel or under proper supervision. Misdirection or mishandling can result in the product falling into the hands of uninformed recipients or causing human or environmental risk. Proper packaging is also important to ensure the confinement of the product and its safe handling. The original package is intended to ensure safe distribution; when repacking is necessary, the new packing should meet the specifications of the original packaging.

4.2.1.3. Spray Technique:

Target surfaces

Generally, all the interior walls and ceilings are treated. In addition to permanent human dwellings, field huts where people sleep during the planting or harvesting season should be sprayed. The underside of furniture, back of the doors, outside eaves and porches must be treated. Human dwellings and mixed dwellings should be sprayed, but **not cattle sheds**, with a view to conserve insecticide, improve coverage of human dwellings and prevent diversion of mosquitoes from cattle sheds to human dwellings. The residual effect of insecticides may be short on some surfaces, e.g. porous mud walls, oil painted wood and alkaline white wash, so these may require re-treatment after for example three months.

Preparation of insecticide suspension

The required quantity of insecticideshould be issued to the squads each day by the supervisor after checking balance stocks available from previous day's supplies.

The preparation of the spray suspension is made just before the start of the spray operations every day. It is important that the suspension is made correctly so that the correct dosage is applied on the sprayed surfaces. The procedure for the preparation of the suspension is the same irrespective of the insecticide. However, the quantity of the insecticide used per 10 litres of water will depend on the insecticide used.

The required quantity of the insecticide is measured with a plastic mug and poured into a 15 litre bucket. A paste is made with a small quantity of water. The remainder of water is then poured slowly into the bucket and the insecticide water mixture is stirred vigorously to obtain a uniform suspension. The suspension is then poured into another bucket through a cloth sieve to remove any particulate matter that might clog the nozzle of the spray pump. The insecticide suspension should be stirred vigorously at least every hour.

Spraying

All food, cooking utensils, bedding and clothes must be protected from insecticide by taking them outside the house before spraying starts. Alternatively, they need to be covered by a plastic sheet.

The barrel of the stirrup pump is put in the bucket containing the spray suspension. One man operates the pump and the other man sprays. The spray lance should be kept 45 cms (18 inches) away from the wall surface. The swath should be parallel. Spray is applied in vertical swaths 53 cm (21 inches) wide. Successive swaths should overlap by 7.5 cm (3 inches). Spray is done from roof to floor, using downward motion, to

complete one swath; then stepping sideways and spraying upwards from floor to roof. Do not let the spray drip to the floor. Spraying is done on inner surfaces including eaves and roofs.

The discharge rate should be 740 to 850 ml per minute. To obtain the above discharge rate, the pump man should give 20 to 26 strokes per minute with 10-15 cms plunger movement at a pressure of 10 PSI (0.7 kg/sq.cm) at the nozzle tip. Spraying into a bucket for one minute and measuring the quantity of the suspension in a graduated mug will check the correct discharge rate (740 to 850ml/minute). The nozzle tip should be discarded if the discharge rate exceeds 850 ml per minute.

If the spray stops due to a blockage in the nozzle, the nozzle cap should be unscrewed to remove the blockage and replaced with a new one. The blocked nozzle should be put in a container with water for a few hours before the blockage is removed with a finer wire.

A good quality spray should lead to uniform deposit on walls and other sprayable surfaces. This is easy to verify for DDT and malathion sprays as the insecticide deposits are clearly visible. Deposits of synthetic pyrethroids are visible on wooden structures. The supervisor through physical verification should verify the quality and coverage of spray randomly.

It takes about 5 minutes to spray a house with an average surface area of 150 sq. metres. A summary of spray operations in each village should be maintained by the superior field worker and verified by the health worker showing the areas covered and room coverage (Form VC1).

4.2.1.4. Planning for spray operations:

Spray schedule:

Rounds	Period	Insecticide
I round	1st March to 30th April	DDT, MAL,SP
II round	15th July to 15th Sept	DDT, MAL, SP
III round	1st Oct to 30th Nov	MAL

Calculation of area and population for spray:

Make a list of all subcenters (MPW sections) in different PHCs which have API 2 and above in any of the last three years. Prepare a table as below:

Sl No.	Name of the taluk	Name of the PHC	Total MPW Sections	Total Pop	Targeted Town	Villages	Population To be covered	Period of Spry From To	NO pf HD MD	DDT Required	No of Pumps required	No of Men required	Wages required	POL required	O.E Required	Total Amount required
1																
Total																

After noting the eligible population, the number of houses can be estimated by dividing the population by five.

As per the information received from the state headquarters, decide on the area / population for the type of insecticide i.e. DDT, Malathion and Synthetic Pyrethroid.

Prioritization of areas for spray: In case of shortage of insecticide, prioritize the area selecting high risk areas (as per High risk criteria of MAP 95), earmarked areas taking sub-centre as a unit with more than 5 API provided ABER > 10% or if ABER is <10%, then SPR >5% and Pf% >50%, drug resistant areas, project areas and other vulnerable areas.

Calculation of insecticide requirement:

Use the following formulas to arrive at insecticide requirement:

a. DDT: 150 MT per million population for two rounds of spray are required.
b. Malathion 25 %: 900 MT per million population for three rounds of spray are required.
c. Deltamethrin 2.5% WP: 60 MT per million population for two rounds of spray.
d. Alphacypermethrin 5% WP 37.5 MT per million population for two rounds of spray
e. Cyfluthrin 10% WP: 18.75 MT per million population for two rounds of spray
f. Lambdacyhalothrin 10% WP: 18.75 MT per million population for two rounds of spray
g. .Bifenthrin 10% WP: 18.75 per million population for two rounds of spray

It can also be calculated based on the houses to be sprayed:

1 house of 150 Sq. mts can be covered with 300 gms of DDT, 1200 gms of Malathion, 120 gms of deltamethrin, 75 mg of Alphacypermethrin, or 37.5 gms of Lambdacyhalothrin / cyfluthrin / Bifenthrin.

Calculation of wages:

- Each spray squad consists of:
  - 1 Superior field worker
  - 5 Field workers
  - 2 Stirrup Pumps

Each pump should cover 50 houses in a day. Therefore each squad can cover 100 houses. In hilly and difficult terrain and areas with scattered houses, the squad can cover 60 to 80 houses. The five sprayable surfaces of a room add up to 50 sq metres. Each house is expected to have 3 rooms. So each structure (house) is assumed to have a sprayable surface area of 150 sq meters.

Calculate squad days or pump days based on the houses to be sprayed.

Squad days: No. of houses to be sprayed divided by 100

Pump days: No. of houses to be sprayed divided by 50

Wages are calculated based on the number of squad days or pump days and the existing rate per day.

Equipment for each squad:

- Stirrup Pumps – 2
- Spare nozzle tips – 2
- Buckets (15 Lts) – 4
- Buckets (5-10 Lts) – 1
- Asbestos thread – 3 mts
- Measuring mug – 1
- Straining cloth – 1 Mt
- Pump washers – 2
- Plastic sheet (3 x 3 Mts) – 1

Two types of hand operated sprayers are used for indoor residual spraying: i) Hand Compression pumps; ii) Stirrup pumps.

HAND COMPRESSION SPRAYER PUMP:

A hand-compression sprayer consists of a tank for holding a liquid insecticide formulation, which can be pressurized by means of a hand pump attached to it. The compressed air forces the liquid from the tank via a hose with a cut-off valve, a lance and a nozzle.

The barrel of the sprayer should be capable of withstanding an internal pressure of 14 kg./cm^2 and for this purpose the metal walls should not be less than .63 mm thick. The diameter of the plunger shaft should not be less than 12mm. The plunger bucket of the pump should be made from nitrile rubber or chrome-tanned leather. The plunger assembly should be easily removable for cleaning and repair in the field. The handle may be **D** or **T** type. The handle grip should be about 30 mm in diameter. Further, the length in the case of **T**- type handle should not be less than 20 cm.

Following actions may be ensured by the operators/supervisors:

- The compression sprayer is pressurized before commencing spraying and not continuously pumped. The pump is filled to levels usually at about ¾ liquid to ¼ air. A smaller air volume in relation to liquid volume would not retain sufficient pressure for long periods.
- When the tank is not in use, the spray lance is held in a bracket and nozzle cup, which protects the nozzle from damage.
- The nozzle tip is the most important part of the sprayer. It should deliver a precise amount of spray suspension per minute (740-850 ml) at a certain pressure (40 PSI or 2.8 kg/cm^2)in the tank, and maintain a uniform spray pattern and swath width (53 cm or 21").
- The flat-fan spray (Flat Fan) nozzle delivers a fan-shaped spray, and is used for residual wall spraying.

- The flat-fan spray nozzle used for indoor residual spraying which produces a spray with an angle of 60^0 and 750-840 ml. per minute output at a standard tank pressure of 40 PSI (2.8kg/m^2). It is usually made of specially hardened stainless steel. The nozzle tip is designed with flat surfaces on either side of the orifice so that it can be removed easily. The pressure at nozzle tip is calibrated at 10 PSI (.7 kg/cm sq).
- The inside tank should be thoroughly cleaned.
- The distribution hose and accessories should be securely attached to the delivery outlet. The cut-off valve should be tightly closed.
- Full strokes to be pumped till the pressure gauge registers 2.8 kg/cm sq. (40 PSI)
- The sprayer must be suspended on the shoulder or carried in hands.

STIRRUP PUMP

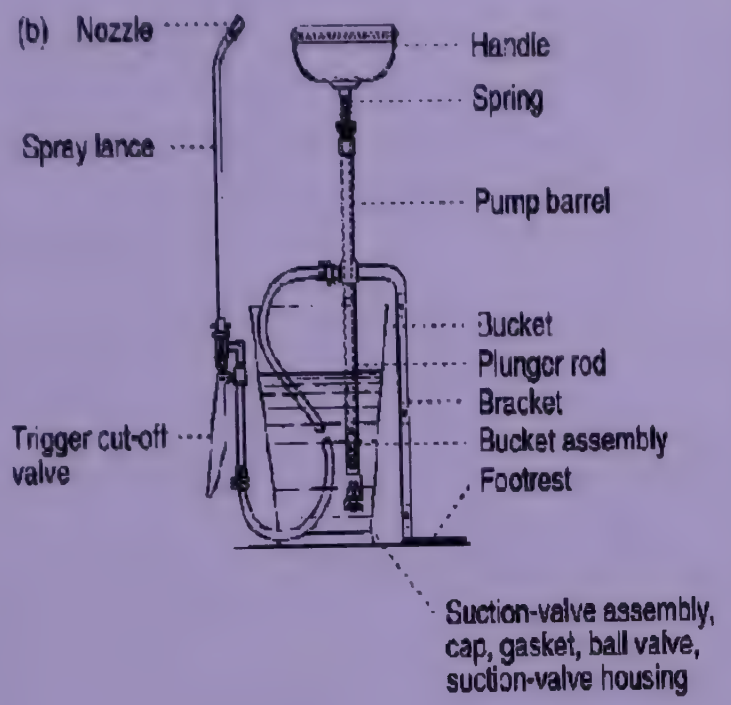
The stirrup pump sprayer consists of a brass pump, a foot rest (stirrup), a hose, a lance and a nozzle. The pump is lowered into the liquid in a bucket and held in position during operation by placing the foot on the flat stirrup provided for the purpose. The stirrup is attached to the pump with a bracket. It should preferably be attached to the pump by a clamp so that adjustment can be made for buckets of different depths.

The principle of working with the stirrup pump and all other sprayers working on the pump system is the same. With the suction stroke (upward stroke) of the piston, the suction valve opens and the liquid enters the barrel. During the pressure stroke, the suction valve closes and the delivery valve opens to permit the entry of the liquid into the pressure chamber or directly into the spray lance, as the case may be. In the former case, a few pump strokes to build up air-cushion in the pressure chamber before starting the spraying operation are required.

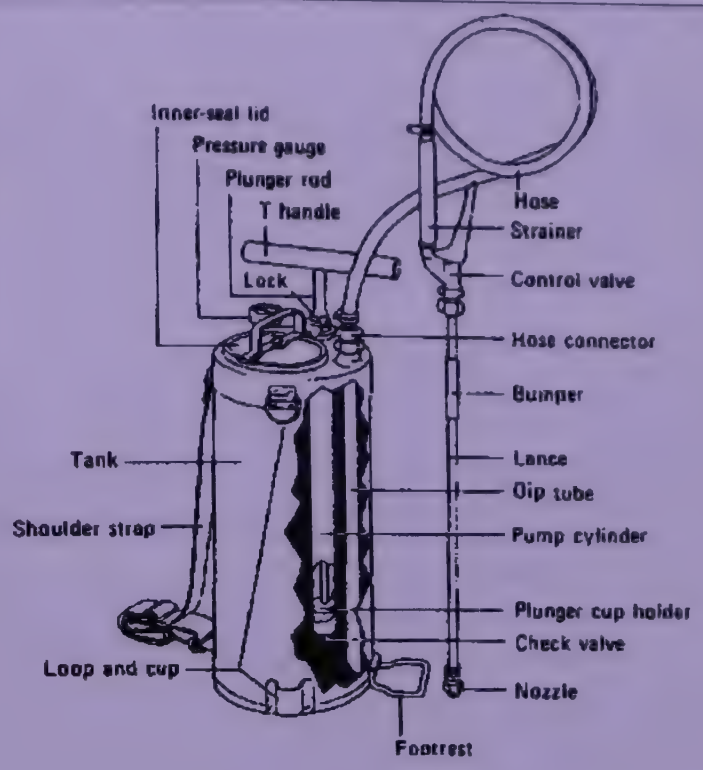
Two persons are employed for working the sprayer – one to operate the pump and the other to direct the spray from the nozzle at the end of the spray lance. The length of the hose normally supplied with these sprayers is approximately 5m, but can be varied according to the requirement of the user.

- The sprayer mechanism must be clean and in working order.
- The stirrup pump sprayer bucket should be filled about 2/3 of strained prepared insecticide and the pump placed in the liquid. The liquid may be agitated by inserting the nozzle in the bucket and pumping at least ten times.
- The pump plunger may be operated through a stroke approximately 4-6 inches in length and at the rate of 24-26 cycles per minute.
- The supply worker will replenish insecticides as needed, assist spray operator to keep hose line from kinking and assist pump worker to move stirrup pump and bucket as spray operations proceed.
- The tip may be subject to occasional clogging. When clogging occurs, the tip may be taken out and the obstruction cleared by fine brush.
- The nozzle should be replaced whenever it gives and uneven spray pattern, shows signs of damage, or discharges excessive insecticide.

STIRRUP PUMPS



COMPRESSION PUMPS



Common mistakes during spray operation

1. Spray schedule not available with the spray squads.
2. Incorrect quantity of DDT used for making suspension for spray solution.
3. Spray suspension not being stirred continuously during spray.
4. Leakage of spray suspension from stirrup pump-joints.
5. Defective nozzle tip – excessive discharge rate (more than 900 ml. per minute) and inadequate spray swath.
6. Spray on walls and roof patchy and partial due to defective spay technique or nozzle tip.
7. Partial coverage of human dwelling i.e. only part of the houses/rooms are being sprayed.
8. Prior intimation of spray not given to the villagers.
9. Lack of involvement of panchayats, ASHA, and other volunteers in spray operation.
10. Safety measures not being observed – the food articles in the household not covered before starting spray operation.
11. Stencilling outside the sprayed houses is not being correctly made depicting houses no., total rooms and sprayed rooms (as per VC 1S format).
12. Storage of DDT not at proper place – kept in open and exposed to sunlight.
13. Spray workers not taking safety measures like washing of hands and other exposed body parts after spray.
14. Health workers not accompanying the spray squad for supervision of spray squads.
15. Daily summary report not being maintained to determine the number of houses/rooms sprayed and insecticide consumed and balance available at the end of day.

Prepare a plan for transporting and dumping of the insecticide in PHC, storage etc.

4.2.1.5. Supervision, Process and Performance Indicators

Supervision of spray operations is important to ensure that operations are carried out according to correct technical procedures, so that corrective action can be taken, to achieve the programme goals. Supervision is carried at all levels of programme implementation. It can be concurrent or consecutive. A stratified sample should be taken for consecutive supervision.

Concurrent supervision (During the spray operations):

The following should be checked during such inspections:

- Date of advance notification and the maintenance of time table for spray operations
- Turn out of spray crew
- Nozzle tip discharge rate
- Conditions of spray pumps
- Preparation of insecticide suspension
- Actual spraying operation including the technique, speed and coverage etc.
- Extent of refusal to accept spray and the numbers and percentage of locked houses
- Maintenance of spray records
- Consumption of insecticide as determined by the quantity issued and stock in hand
- Date and time of checking of the squad by Inspectors/ Supervisors and other supervisory personnel and their remarks, if any
- Arrangements for mopping up
- Future programme and time schedule
- Whether exterior has been sprayed

Consecutive supervision (after the spray operations):

The following is to be checked in consecutive supervision

- Evidence of insecticide deposit on sprayable surface particularly on the ceiling and wooden material like windows etc.
- Dispersal of the insecticide deposits on the walls to verify uniformity of deposits
- Number of rooms in each house sprayed satisfactorily, partially and not at all
- Percentage of refusals and locked houses
- Factors responsible for not spraying any area as elicited through enquiries from the residents
- Attempts made for mopping up operation in the event of high refusal
- Extent of mud plastering on the walls, if any and other relevant matters.

Community Participation:

Involvement of Panchayats is essential for successful IRS. Panchayats/ village/ local bodies/ village heads/ Block Development Officers/ Mahila Mandals/VHSCs, religious groups etc., are to be informed about spray schedule at least a fortnight before the spray. Panchayat Development Officer (PDO) is the most crucial link in this regard. This advance information must be given by Surveillance Workers/Malaria Inspectors/ District Malaria Officer so as to facilitate the villagers to extend full cooperation in getting the spray inside human dwellings with the objective of full coverage of targeted population. Local activities like miking in villages, village level meetings and rallies are to be organised.

4.2.2. Insecticide Treated Bed nets (ITNs)

Ordinary untreated mosquito nets provide limited physical barrier between mosquito and the man and protection as they may still bite through the net or get inside the net, if it is torn or not used properly. Mosquito nets treated with insecticides provide much more effective protection by killing mosquitoes as well as repelling them. Insecticide treated nets, like IRS, also reduce the longevity of vectors. A number of studies have shown that ITNs have a community effect, when the population coverage is 60% or higher.

Combination of ITNs and IRS is possible, but as long as it has not been proven to be cost-effective, it will be too costly an option, given that the programme does not yet have sufficient resources to protect all high risk populations.

Long-lasting insecticidal nets (LLINs) are mosquito nets/bed nets, which have insecticide incorporated in their fibre, so that it is not removed by as many as 20 washes. Because these nets have an even and quality controlled insecticide application, they are generally more effective than conventional ITNs.

Criteria:

a) **For selection of high endemic sub Centers (SCs) to be covered with LLINs:**
All high endemic SCs (API≥2) are to be protected by IRS and /or ITN (Insecticide Treated Bet Nets)/LLIN (Long Lasting Insecticidal Nets). However depending upon the quantity of LLINs available, district may prioritize the high risk SCs under 3 categories (API ≥ 10;API 5-9.99;,API 2-<4.99;API 1-1.99), this information being generated separately by the states under stratification. The district should select SCs from the first priority area and if more LLINs are available then consider for 2, 3 priority areas.

b) **For assessment of high risk villages for LLIN and their population:**
All the villages in the identified Sub Centres are to be distributed LLINs irrespective of their individual village API.

c) **Priority for high risk groups:**
Pregnant women and young children (under five): adequate awareness campaign should be undertaken among the targeted community so that each family protects the pregnant mothers and the children under five as they are more vulnerable to Malaria.

Preparation of Action Plan

4.2.2.1Survey and assessment

i) **Selection of PHCs/ Subcentres for ITNs**: The first step is to identify the district, PHC and Subcentre based on the criteria mentioned at Section 2.3 for promotion of ITN programme. Thereafter, size of the target population should be determined. Once the target population is defined, an estimate of bed nets should be made to achieve the total coverage.

ii) **Survey for family size**- To estimate the requirement of ITN/LLIN for total coverage of the targeted population, a survey of families in selected PHCs/sub-centers should be undertaken. Directorate of NVBDCP envisages over 80% effective coverage. The information to be collected during the survey includes name of the head of the family, total family members, Names of family members, age, sex, to estimate the actual numbers of ITN /LLIN required. Each family would be provided a card, which would be known as ITN /LLIN card where details about the family should be recorded. The ITN /LLIN cards should be handed over to the families. In future, these could be used as a monitoring tool for ITN /LLIN programme. This survey should be done by health workers (male/female) in collaboration ASHA/Anganwadi workers and other volunteers at the village level. However, the single huts should not be left out and as per need they should be provided ITN /LLIN. Migrants, Pregnant women, infants and children below 5 years, Hostellers, have to be given priority for the use of bednets.

iii) **Assessment of the requirement of bednets**
After the survey of the population, the requirement of the ITBN /LLIN for each family can be calculated. Each family of five members can be given two nets .However, with the sleeping pattern of the family members, the requirement may vary. It is presumed that atleast there would be two sleeping rooms in

each household, therefore atleast in each of the sleeping rooms one ITN/LLIN would be used, so that the non-users also get partial protection due to exito-repellent and deterrent effect of ITN /LLIN.

iv) **Assessment of community owned bednets(CBN) in selected areas**– The survey should also enumerate the families with CBN in an area. There are many areas, where people are habitual users of bednets.The existing CBNs should also be taken into account while preparing a plan for treatment of bednets supplied under the programme. During the survey, efforts should be made to generate information regarding the source of purchase of CBN, as this information would be vital for sustainability of the programme and developing social marketing strategy for promotion of ITN.

4.2.2.2 Distribution of LLINs in a village:

LLIN distribution should be done preferably prior to the transmission season i.e. before the onset of monsoon. However, due to constraints in supply and logistics, LLIN may be distributed across the year. If the supply is available during the transmission season, then district should take all possible measures to make it available to the beneficiary at the earliest.

4.2.2.3 Distribution in the villages:

LLINs are to be distributed in eligible villages through ASHAs who would be responsible for undertaking IEC/BCC campaign in each household of the village before, during and after the distribution of nets to maximize community participation/involvement. ASHAs should be briefed/ trained in advance for carrying out this activity. Post-distribution, ASHAs should follow-up with the villagers for compliance in proper LLIN usage. This opportunity should be utilized to sustain/enhance the ASHAs' involvement in other activities for malaria prevention/control (e.g. diagnosis, treatment, referral, IRS etc.).

4.2.3. Bio-environmental control:

The breeding of anophelines can be reduced by a variety of physical, chemical and biological methods. In most situations these methods have less impact than methods, which, like IRS and insecticide-treated bed nets reduce the longevity of adult vectors. However, in some areas, larval control can play an important role, either alone or as an adjunct to IRS or bed nets.

NVBDCP recommends using larvivorous fish in man-made breeding sites in rural and peri-urban areas, freshwater bodies in rural areas. In rural areas, larval control plays a greater role in arid areas, where breeding sites are scarce and well delimited. In contrast, in forested areas and other areas with dense vegetation, it may not be practically possible to identify and target enough of the breeding sites. Larvivorous fish are widely used in urban areas, but are being expanded to all feasible areas, including rural areas. For details, see G*uidelines of Larvivorous Fish for Vector Control* at http://www.nvbdcp.gov.in/iec.html.

5. FRAMEWORK FOR MALARIA ELIMINATION (2016–2030)

VISION

Eliminate malaria nationally and contribute to improved health, quality of life and alleviation of poverty.

GOALS

The goals of the *National Framework for Malaria Elimination in India 2016–2030* are:

- Eliminate malaria (zero indigenous cases) throughout the entire country by 2030; and
- Maintain malaria–free status in areas where malaria transmission has been interrupted and prevent re-introduction of malaria.

OBJECTIVES

The objectives are to:

(1) Eliminate malaria from all Category 1 and Category 2 states/UTs (26) with low and moderate-transmission of malaria by 2022;

(2) Reduce the incidence of malaria to less than one case per 1000 population per year in all states/UTs and their districts and achieve malaria elimination in 31 states/UTs by 2024;

(3) Interrupt indigenous transmission of malaria in all states/UTs (Category 3) by 2027; And

(4) Prevent re-establishment of local transmission of malaria in areas where it has been eliminated and maintain malaria-free status nationally by 2030.

The main focus of this Framework is to propel the country /state on the path towards malaria elimination in a phased manner. Based on the guidelines, the district is the implementing unit and the sub-centres are identified as the basic unit for surveillance, data collection and taking appropriate control measures. Based on this, the categorization is made for Sub centres and the villages will be classified as: villages with 0 API; villages with 0 – 1 API; villages with 1 – 2 API; villages with 2 – 5 API; villages with 5 and more API;

As detailed in Table below, Districts will be subdivided into four categories with annual parasite incidence (API) as primary criteria and other malaria indicators such as the annual blood examination rate (ABER) and slide positivity rate (SPR) as secondary criteria. Subsequently, category specific milestones and targets will be set and specific strategies will be implemented.

Classification of Sub-centres/villages based on API as primary criteria:

Sl.No.	Category	Definition
1	**Category 0:** Prevention of re-establishment phase	Sub centres with zero indigenous cases of malaria
2	**Category 1:** Elimination phase	Sub Centres reporting an API of less than 1 case per 1000 population at risk and all villages showing API less than 1.

3	**Category 2:** Pre-elimination phase	Sub Centres with an API of less than 1 case per 1000 population at risk, but some of their villages are reporting an API of 1/1000 or above.
4	**Category 3:** Intensified control phase	Sub Centres with an API of 1 case per 1000 population at risk or above.

Key interventions:

Category	Strategies to be adopted
Category - 0	• detect any re-introduced case of malaria; • notify immediately all detected cases of malaria; • determine the underlying causes of resumed local transmission; • apply rapid curative and preventive measures; • prevent re-introduction and possible re-establishment of malaria transmission; andmaintain malaria-free status in these areas.
Category -1	• In elimination areas, where transmission is focal and incidence/risk has become extremely low, all efforts will be directed at interrupting local transmission in all active foci of malaria. • Mandatory notification of each case of malaria from the private sector, other organized government sectors or any other health facility. • Adequate case-based surveillance and complete case management established and fully functional to handle each case of malaria.
Category-2	• Investigation and classification of all foci of malaria. • A strict total coverage of all active foci by effective vector control measures. • Early detection and treatment of all cases of malaria by means of active and/or passive case detection to prevent onward transmission.. • Implementation of interventions for effective screening, management and prevention of malaria among mobile and migrant populations. • Establishment of an effective epidemic forecasting and response system. • Ensuring rigorous quality assurance of all medicines and diagnostics. • All positive and a fixed percentage of negative slides will be cross-checked. • During investigation of foci, all suspected cases of malaria are to be screened for malaria. These could include household members, neighbours, schoolchildren, workplace colleagues and relatives. • Surveillance of special groups, migrant populations or populations residing in the vicinity of industrial areas are also to be covered under surveillance operations.

Category-3	• Massive scaling up of existing disease management and preventive approaches and tools, aimed at a significant reduction in the prevalence and incidence of malaria as well as associated deaths. • Screening of all fever cases suspected for malaria. • Classification of areas as per local malaria epidemiology and grading of areas as per risk of malaria transmission followed by implementation of tailored interventions. • Strengthening of inter-sectoral collaboration. • Special interventions for high risk groups such as tribal populations and populations residing in conflict affected or hard-to-reach areas. • Timely referral and treatment of severe malaria cases to reduce malaria-related mortality. • Establishment of a robust supply chain management system. • Maintenance of an optimum level of surveillance using appropriate diagnostic measures. • Equipping all health institutions (primary health care level and above), especially in high-risk areas, with microscopy facilities and RDTs for emergency use and injectable artemisinin derivatives for treatment of severe malaria.

6. Recording and Reporting

Traditionally the programme has compiled epidemiological data through a system of sixteen manual reporting formats, ranging from MF1 to MF 16, which are exhaustive in reporting. In the past few years the anti-malaria programme has undergone significant policy changes. Newer interventions including RDTs and ACT have been introduced at the peripheral level and bednets have been distributed which will be scaled up rapidly in the coming years. It is important to closely monitor their utilization. For the purpose of routine recording and reporting the following M-1 to M-4, VC-1 to VC-6formats and Programme Management Monitoring Report have been introduced.

6.1 Case Detection and Management:

- M-1 : Report of Surveillance by ASHA/ MPW/ Health facility
- M-2 : Laboratory Request for Slide Examination
- M-3 : Record of slide Examination in PHC Laboratory
- M-4: Fortnightly Report of Cases From Subcentre/ PHC/ District/ State

6.2 Integrated vector Control:

- VC-1: Primary record of IRS
- VC-1S: Wall Stencil
- VC-2: District IRS output Form
- VC-3: Primary record of bednet delivery and impregnation
- VC-4: Bednet Delivery and Impregnation form
- VC-5: District Annual Stock report on vector control supplies
- VC-6. IVM Plan - Block level

MF 1 register is to be maintained for every village showing the details of all the households. The register is to be updated every year in January.

A. Report of Fever Cases by ASHA/ MPW/ Health facility (M1)

This is the primary case record for all suspected malaria cases i.e. it is actually a line list of all fever cases. This form is to be filled by any health facility/ worker which are directly involved in case detection and treatment. Therefore an ASHA or any other Community Volunteer, MPW and MO would maintain case record in this format. In M1, each row corresponds with one patient record. Serial No is filled in column 1 which is started fresh each month. Details of village, village code, name of fever case and Head of Family are entered in Col 2 to 5. Each village will be assigned a code for computer based data entry which is to be retained once and for all. In exceptional cases where a fever case is a visitor to the village, 991/ 992 is filled in the respective Col. Whether collection is during Active / Passive surveillance is filled as A or P in Col 6. For all purposes the ASHA/ CHV/ MO PHC will be passive agencies. Therefore in these cases the entry in Col 6 will be always P. It is only an MPW who can be involved in both types of collections. Fever cases coming to the MPW on their own will be entered as P while fever cases detected actively will be entered as A. Age is entered in Years/ months. Sex is to be entered as M for Male or F for Female. Duration of fever,

date of RDT/ BSC, Slide No, sending and receipt of slides, result of examination of slides and RDTs, date of start of treatment, Nos of Tablets, referral and deaths if any are to be sequentially entered in the form.

Slide No is started fresh at the beginning of each year and continued over the subsequent months. Any positive test result is to be marked in red with a tick (√). Entries up to Col 13 are filled for all patients at the time of first contact. If the RDT is positive, the blood slide need not be sent for examination and therefore Col 14 to 18 are to be skipped and are simply slashed (/). Treatment in such cases is started immediately for Pf. In cases where RDT is negative, blood slide is sent for examination and Col 14 to 18 are filled accordingly on receipt of results.

The lower part of the form consists of record of logistics. Opening balance at the beginning of the month, stock received, utilization and closing balance should be entered by ASHA or other service providers after physical verification of stocks.

M1 and M2 replace the MF 2 form which was used earlier.

B. Laboratory Request Form for Slide Examination (M2)

Fever cases are diagnosed using RDT and/ or blood slide. In areas where RDTs are supplied, RDT and blood slide are done at the same time. However, only if the RDT is negative, the blood slide is forwarded to Lab for further examination. Areas where RDTs are not supplied also rely on microscopy for diagnosis. M2 ie the Laboratory Request Form for Slide Examination, is filled in duplicate by ASHA/ DHV/ MPW whenever blood slides need to be sent to the Lab. In this form Col 1 to 7 are filled from M1 by ASHA/ CHV/ MPW. It is to be sent to PHC lab whenever required. E.g. if 2 slides collected by an ASHA in a day, need to be examined, they are entered into M2 and sent to PHC Lab. The result of microscopy and feedback on smear quality are filled by the LT. All efforts should be made by LT to examine the slides on the day of receipt or the following day and send the results back to ASHA/ CHV/ MPW on the same day as examination of blood slides. The results obtained are entered into M1 by ASHA/ CHV/ MPW.

C. Record of slide Examination in PHC Laboratory (M3)

M3 is the Subcentre wise record, of slides examined in the PHC Lab. Slides reach the lab from the ASHA/ CHV/ MPW of the SC area. Slides will also be collected and examined for suspected malaria cases referred from the PHC OPD. Therefore at the beginning of each year, the M3 register is divided into sections for different subcentres as well as PHC OPD. In each subcentre section serial no's are started fresh at the beginning of each year. Record of slides sent along with M2 is entered serially into M3. As soon as M2 is received Col 3 to 10 are entered from M2 followed by the date of receipt. The date on which the slides are examined is entered in Col 2. The slide results are entered in Col 13, 14. The remarks column can indicate the quality of smear and other information like reasons of delay in examination.

D. Monthly Report of Cases (M4)

It is a village-wise/ provider-wise / subcentre wise monthly consolidation of all M1 forms belonging to a subcentre/ PHC area. The MPW compiles all M1s of his subcentre area into M4. During compilation the Subcentre MPW will fill out aggregates of each health care provider in Subcentre area in one row and in the last row enter the compilation of his own M1. The report is made in triplicate and 2 copies are

forwarded to PHC at the end of the month. The PHC does a Subcentre wise compilation in a similar M4 format and in the penultimate row enters the consolidation of PHC M1. The PHC forwards its M4 to the district. The district further compiles this data and sends a PHC wise report to the state. The district is required to enter Subcentre wise data from M4 of PHCs into NAMMIS as soon as the reports are received to avoid delay in transmission of reports.

The present system of inwarding in MF 8 register maintained in the PHC laboratory may be discontinued. Instead, M-3 format of Register should be maintained. The other reports and records that are to be maintained at the PHC laboratory are:

MF : 7 – Positive Case Register (Village wise & Sub-Centre wise)

MF: 9 – Epidemiological Evaluation Master Chart or Register

MF:10 – Passive Register / Chart along with Provider wise details for M-4 Provider wise reporting

Daily Log Chart of examination showing performance of Malaria Microscopy by Lab Technician

7. Monitoring and Supervision

Medical Officer, as the programme manager for the PHC, is expected to monitor the prevention and control of malaria activities regularly. This can be done in following ways:

7.1 Review of records:

Malaria is one of the best documented health programmes. An analysis of the records at the PHC would give sufficient avenue for monitoring the programme. The two important registers are MF 8 and MF 9. The MO should spend at least an hour each week in the laboratory / office to study these two registers which would show the efficiency of the surveillance activity in all the villages / subcenters in the PHC. They would show the number of blood smears being collected from each village, the periodicity / regularity of collection, any delay in dispatch of blood smears etc. The MF 7 register would show the details of positive cases namely age and sex, time lag between collection to examination to RT, follow up blood smears etc. Analysis of epidemiological parameters like blood examination rate (BER), parasite incidence (PI), slide /test positivity rate, P.f % has to be done for all villages / subcenters to measure the efficiency / effectiveness of surveillance. Details of these parameters are given below:

Annual Blood smear Examination Rate (ABER)

$$\text{ABER} = \frac{\text{Number of blood smears examined in a year}}{\text{Total population}} \times 100$$

ABER reflects efficiency and adequacy of case detection. Based on the estimated fever rate in India, a minimum ABER of 10% was fixed under the programme; the blood smear collection should not be less than 1% per month during the transmission period.

- ABER should be equal to fever rate in the locality.
- Fever rates in the community differ from season to season; hence different targets should be fixed for different seasons / months of the year.
- Ensure that all localities are covered regularly under surveillance, as per prescribed time schedule.
- If some villages are not covered by surveillance during the transmission season, there is a great danger of focal outbreaks.

The MO-PHC should

- Scrutinize the epidemiological data and compare village-wise and fortnight-wise targets with actual blood smear collection, positives every month, and every fortnight during pre-transmission and transmission period.
- Correlate reports of fever incidence or OPD fever attendance from these areas.
- Become concerned with the situation and take further stepsin case of high fever rate or low collection of slides.
- If the blood smear collection is very high and laboratory results show low positivity rates, MO-PHC should be alert and investigate the efficiency of the laboratory and verify the microscopic diagnosis.

Monthly Blood smear Examination Rate (MBER)

$$\text{MBER} = \frac{\text{Number of blood smears examined in a month}}{\text{Total population}} \times 100$$

Instead of ABER, monthly blood examination rate should be compared with previous month's performance and corresponding month of the previous year to analyze the trend of fever rates in the community.

Annual Parasite Index (API): (Mandatory Parameter)

$$API = \frac{\text{Total No. of positives for malaria parasite in a year}}{\text{Total population}} \times 1000$$

- API depends upon the adequacy of ABER; in areas with low ABER, the significance of API is lost.
- If ABER is satisfactory, API becomes the most important criterion to assess the malaria prevalence in the community.
- API is also used under the MPO for decision on spray operations.

Annual falciparum Index (AfI)

$$AfI = \frac{\text{Total number of positives for } \textit{P.falciparum} \text{ in a year}}{\text{Total population}} \times 1000$$

- It is the proportion of total positives for P.falciparum infection in the total population under malaria surveillance.
- Similar interpretation should be applied to AfI as for API.

Slide Positivity Rate (SPR)

$$SPR = \frac{\text{Total No. of blood smears found positive for malaria parasite}}{\text{Total no. of blood smears examined}} \times 100$$

- SPR is less dependent on ABER; it is more reliable than API even for those years when ABER fluctuates from year to year.
- Whenever the case detection mechanism is inadequate, this is a dependable parameter for determining the progress of containment measures.
- SPR assumes greater significance, if the ABER is low and gives better indication of parasite load in the community.

Slide falciparum Rate (SfR)

$$SfR = \frac{\text{Total No. of positives for } \textit{P.falciparum}}{\text{Total no. of blood smears examined}} \times 100$$

- SfRis also less dependent on ABER
- It pinpoints areas of *P.falciparum* preponderance for prioritizing control measures.

P.*falciparum* percentage *(Pf %)*

$$Pf\% = \frac{\text{Total no. of positives for } \textit{P.falciparum}}{\text{Total no. of positives for malaria parasite}} \times 100$$

- Pf % gives the relative proportion of *P.falciparum* infection and trends in relation to total case load.

- Any rise in *P.falciparum* percentage also indicates breakdown of malaria control activities leading to high morbidity and high mortality.

7.2 Review of the performance of the MPWs during the weekly / monthly meetings:

Weekly / Monthly program reviews:
The MO-PHC should set aside one day in every month for a detailed program review apart from brief weekly meetings. It should be ensured that the data of previous month, findings of last round of LQAS and observations from the field visits are available during the review. All relevant staff of the PHC including the store keeper and the lab technician should be present during the review.

While reviewing the data, specific questions will be asked for each problem to find out the reasons and then look for possible solutions. Once a solution has been arrived at, specific responsibilities will be assigned to the appropriate staff member for execution of the duty and a deadline set for its execution. For urgent issues, the deadline set is an earliest possible date / time, but for most other issues, the next monthly review should suffice.

In between monthly reviews, the staff should be reminded during interactions about what they are expected to do.

Questions which should be asked during the monthly program reviews:

- Does every village / hamlet / cluster / home have easy access to ASHA ?
- Is there any ASHA who has not reported during the current month?
- Is there any village / hamlet / cluster for which information is not available this month?
- Was there any outbreak reported in the last month by aASHA / FTD that was not attended in time by PHC staff?
- Was there any stock-out in RDT / ACT reported by any ASHA? What was the reason? What was the mechanism responsible for ensuring continuous supply and why did this fail?
- In the "slide" villages, what proportion of slides reports reached the village later than one day after dispatch from the village? Review the reasons: has a mechanism for timely transport and reporting been established for every such village? Who are responsible for this mechanism? Which part of this mechanism is not working, why?
- How many slide reports did not reach the village level ASHA in time for making the monthly report? How can this number be reduced next month?
- In all villages, what proportion of fever cases were tested within a day of the start of fever? Is there a difference between MIS and last round of LQAS? What could be the reasons? Review examples of cases, and find the reasons: Are people in the village aware of the presence of the ASHA? Why do they not consult the provider on time? What additional inputs are needed to make this happen?
- Are there any problems being reported in the use of RDT? If there are a lot of RDT negative fever cases, what is the likely cause – is it not malaria, or could it be a problem with the test?
- Are RDTs being stored and used properly? Is this being supervised by MPW / Health Inspector?

- Have all ASHA learnt to do RDT confidently? Who are the providers who need extra support? How best can such support or training be provided? Is it necessary to replace any local provider?

- Are the trends of disease indicators (fever incidence, test positivity) along expected lines? Are there any big changes since the last month, or since the same season the previous year?

- Are there cases of possible severe malaria or deaths from fever reported this month? Are all providers being encouraged to report these? Are there any barriers to reporting these?

- Have all cases of death been investigated? Did all cases of death or severe malaria receive attention in time? Were they tested in time? Referred in time? Was a dose of ACT given before referral in each case?

- Are ASHA / volunteers having problems with recording or reporting? Can they read and understand lab reports?

- In the villages planned to be covered with bed nets, are there families that do not have sufficient bed nets for household size? Are they poor families? How can this gap be quickly filled? In any of these villages, is it time to re-impregnate?

- Are there any reports of resale of nets, or abuse of nets?

- What proportion of people sleep under the bed nets? Is there a difference between perception of health workers and LQAS findings? What could be the reasons? What planned steps have not yet been taken to inform and advise people to use bed nets?

- Has the laboratory been able to cope with the load last month? If not, why not? Are there quality issues with microscopy?

- What is the stock position in the PHC of RDT / ACT / other supplies?

- Are supplies being stored appropriately – particularly RDT (visit the store personally and observe)? What are the problems with storage? Can they be resolved locally?

- During spray season, hold brief weekly reviews and ask the appropriate questions

- During planned bed net distribution and re-impregnation campaigns, ask the appropriate questions during monthly reviews

If there are any issues that cannot be solved at the PHC level, a list of these issues should be made and sent to the DVBDCO; if any of the issues are very urgent, the MO-PHC should speak to the DVBDCOon the telephone and find the solutions.

7.3 Field visits to cross check the performance:

The MO-PHC may, during their field visits, make relevant observations on the following:

- Use LQAS tools for gathering information on case detection and management, bednet utilization
- IRS effectiveness
- Awareness of malaria
- Assessment of awareness and skills of ASHAs
- Examine records of ASHA / volunteers and health workers
- Examine level of stocks
- Look for unreported outbreaks

8.COMMUNITY PARTICIPATION AND BEHAVIOUR CHANGE COMMUNICATION

Community participation:

It is practically impossible to even think of controlling malaria without the active participation and ownership of the public at large, particularly of the poorer sections that bear the brunt of the disease. It is expected that public health action against malaria is a major felt need in high burden areas, and that people do have basic interest and motivation in acting against malaria in these areas.

Since there is much misinformation and misunderstanding of the disease among the public, a strong educational component is a necessity, which can complement the strong "supply-side" interventions (RDT, ACT, ITN/LLIN) that the program now offers. These three interventions have benefits tangible to everyone thus increasing the likelihood of their acceptability and utilization.

Each of these three interventions is likely to be appreciated and demanded by the people, once they become familiar with these interventions. The challenge is to get people to start using them. A fourth component of the program having high acceptance potential is the establishment of trained ASHAs who are providers of RDT and ACT. Other suitable volunteers where ASHAsare not available will complement the efforts of the PHC and sub-centre staff in high-burden areas in the effort to ensure that all residents of such areas have ready access to diagnosis and treatment. A communications strategy that seeks to build the recognition and credibility of the ASHA and other volunteers as a provider can be crucial to the success of the programme.

Health committees at village and PHC levels serve as forums that link providers and users of services and are designed to maximize community and provider ownership of program goals and targets. The scope for community participation in the malaria control program is enumerated in the following table.

Behaviour Change Communication (BCC)

BCC has been defined as a process of learning that empowers people to take rational and informed decisions through appropriate knowledge; inculcates necessary skills and optimism; facilitates, stimulates pertinent action through changed mindsets, modified behavior and reinforces the same. Simplicity, brevity, do-ability and relevance are the cornerstones of effective communication for behavior change. Clear messages, communicated through different, credible channels are most likely to bring about change.

Media mix

- Posters, folders, hand bills, charts, flip charts, flip booklets, stickers, book markers for school children, postal prints, etc.
- Exhibition, folk dance, puppet show, drama, bhajan, kirtan, etc.
- Video quickies, video on wheels, cable TV, etc.

Details of activities to be performed:

Event	Activities	Role & Responsibilities of MOs
1. Observance of National Dengue Day on 16th May every year	1. To bring together various stakeholders & community participation for prevention control of Dengue	To head the Panchayat level meetings and meetings of Stake holders; to organise a Jaatha with suitable banners/placards
2. Observance of Anti Malaria in the Month of June, every year	1. Intersectoral Co-ordination Meeting at District and Taluk level involving other departments / stakeholders.	To identify high risk areas/sub-centers and personally attend all activities in such areas, by suitably planning as early as

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	2. Conducting of Jaatha or Rally involving students. 3. Advocacy sessions involving local and religious ledgers, NGOs, PDO.	May so that all activities can be attended by the MO; To submit the feedback report to the DVBDCO & DHO
3. Observance of Anti Dengue Month in the month of July every year	1. Media coverage and sensitization session at District and Taluk level 2. Collaboration with Private Medical Practitioners Session 3. Jaatha & Rallys. 4. Group / Advocacy sessions. 5. Telecast of TV spots on Dengue. 6. Health Education Camps involving BHEOs 7. Intensified IPC activities by field staff. 8. Debate competitions in High Schools 9. Display of posters on Dengue, Malaria & Algorithm for diagnosis and treatment of Malaria in Strategic places. 10. Wall writings. 11. Awareness camps in village festivals (Jathra). 12. Awareness camps before IRS. 13. LLINs community meetings at village level. 14. Release of bulk SMSs through mobile phone operators.	Local media persons to be briefed and sensitized. Private Medical Practitioners including Ayush doctors to be sensitized on Dengue and DHF cases to be notified/referred to the referral hospitals. To conduct Students' Jaatha and attend / organize HE camps To participate in the School activities and encourage students to eliminate the source of breeding in domestic and peri-domestic situations.
4. Health Education activities throughout the year	1. Pre-IRS sensitization 2. Follow-up of Dengue & Malaria cases by interpersonal communication 3. Periodic visits to the villages with high morbidity rate & to provide necessary Health Education on Vector Control and Environmental sanitation	To visit Spray villages during preparation of advance spray programme or 1 week before the spray schedule operations and contact Panchayat and local leaders for acceptance of spray To visit positive case villages and house hold and sensitize them for adopting proper vector control methods as well as personal protection and prevention of breeding sources in and around the house holds.

9:JOB RESPONSIBILITIES OF MEDICAL OFFICER (MO) PHC TOWARDS MALARIA CONTROL

The MO-PHC is responsible for planning, implementation and monitoring of prevention and control of malaria in the PHC area. He shall carry out the following activities:

Early diagnosis and complete, prompt and effective treatment:

- To make a fortnightly calendar for house-to-house visit of Jr. Health Assistant (Male)
- To select Fever Treatment Depots (FTDs) for the PHC area in consultation with District Malaria Officer (DVBDCO) and the community.
- To refer all fever cases to malaria laboratory for blood smear collection and examination before giving final prescription/medicines.
- To ensure that the laboratory technicians maintain lab registers and also other charts and graphs showing village/subcentre-wise and passive agency-wise blood smear collection, examination and positive cases.
- To ensure/supervise that all positive cases get treatment as per drug policy within 24 hours of examination.
- To ensure sufficient stocks of Rapid Diagnostic Kits (RDKs) and antimalarials in PHC and periphery.
- To analyze data for action and prediction of outbreak and also assist in epidemiological investigation based on weekly /fortnightly fever surveillance report.
- To provide referral services to severe cases of malaria to district hospital / other referral hospitals and to arrange for their transportation.
- To monitor drug failure in malaria cases and inform the District and State Headquarters immediately.
- To ensure that records of clinically diagnosed cases are maintained.
- To undertake training of Sr. HA/ Jr. HA/ ASHA/VHSC/Panchayat members in the PHC area.

Integrated vector control

- To ensure that the spray operations are conducted as per schedule and in case of any delay, he will find out the reasons and reschedule the programme.
- To assist the DVBDCO/ DVBDCO in preparation of supervisory plan for the PHC area.
- To solve bottlenecks in spray operations in his area such as turnover of seasonal spray men (field workers), insecticide supplies, shifting of camps, etc.
- To ensure that reports are sent in time.
- To contact DVBDCO immediately in case of delay/suspension of spray programme and solve the problems.
- To inspect spray operations, during field visits, at least once a week.

Supportive Supervision

- Visit all subcenters once a month
- While on tour, to verify that MPW (Male), MPW (Female) and ASHA carry out malaria case detection as laid down in the policy.

IEC/ BCC

- To plan for anti-malaria month with DVBDCO.
- To plan for a comprehensive IEC campaign in the PHC area.

Recording & Reporting /Monitoring

- To conduct regular PHC level meetings with all the staff to ensure proper implementation of the programme as per guidelines issued from time to time by the concerned authorities.
- To ensure that all MPWs submit the monthly subcentre reports by end of the month.
- To ensure that the monthly PHC report is submitted to the District by 5th of the following month.

M1

M3

56

NATIONAL VECTOR BORNE DISEASE CONTROL PROGRAMME

M4

Name of the PHC		
PHC Code No		

Reporting Month :

Year :

Sl.No	Name of the Subcenter	Subcenter Code	Population of Subcenter	Total fever cases recorded during the F/N in M1	RDT		Blood slides						Total tested (RDT+Slide)	Total Pv	Total Pf	Total Malaria cases	Passive	(Distribution of Total Malaria Cases)									Pf cases treated with ACT	Severe cases treated with Inj arteether	Outbreaks reported (Yes/No)	Stocks out of antimalarials/RDTs of		No. of Malaria cases referred.	No. of Deaths (RDT or slide Positive)	Name/Age/ Sex of Death cases
					No. of RDT performed	+ves	No. of slides taken	B/S examined		No. of slides reported within 24 hrs of slide collection	Pv	Pf						0-4 y		5-14 y		15 + y		SC	ST	Pregnant women				RDT Present (Yes/No)	ACT Present (Yes/No)			
								Total	Passive									M	F	M	F	M	F											
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
	Subcenter																																	
	Subcenter																																	
	PHC Total																																	

Note	Stock position	RDT	Combi blister pack	CQ	0	SP tablets	Inj Arteether at	PQ small	PQ Large	Slides	Lancets	ACT Adult	ACT 0-1	ACT 1-4	ACT 5-8	ACT 9-14
ACT = *Artisunate Combination Therapy*	Opening Balance															
RDT - Rapid Diagnostic Test.	Received during the month															
ACT - Artesunate Combination Therapy.	Total of above															
SP - Sulpha Pyrimethamine.	Utiliziation															
AS -	*Balance*															

No.

Dated:

PHC

Horizontal

Bigger

57.

10. Recommended reading and references

1) Malaria Operational Manual -2016. Publication of Dte of NVBDCP Govt of India available at: http://www.http://nvbdcp.gov.in/Doc/Operational-Manual-Malaria-2016-Version-1.pdf

2) National drug policy on malaria (2013). Publication of Dte of NVBDCP Govt of India available at: http://nvbdcp.gov.in/Doc/National-Drug-Policy-2013.pdf

3) Guidelines for Diagnosis & Treatment of Malaria in India - 2014. http://www.nvbdcp.gov.in/Doc/Guidelines-Malaria-Diagnostic-Treatment-2014.pdf

4) Guidelines for Bivalent Rapid diagnostic tests:http://nvbdcp.gov.in/Doc/guidelines-for-bivalent-rdt.pdf

5) Guidelines-Proper-Storage-Safe-handling-Disposal-Insecticides http://www.nvbdcp.gov.in/Doc/Guidelines-Proper-Storage-Safe-handling-Disposal-Insecticides.pdf

6) WHO Guidelines for the Treatment of Malaria, second edition.Geneva, World Health Organization (2010). http://www.who.int/malaria/publications/atoz/9789241547925/enindex.html

7) Regional guidelines for the management of severe falciparummalaria in small hospitals, World Health Organization, RegionalOffice for South-East Asia (2006). New Delhi, WHO/SEARO. http://www.searo.who.int/LinkFiles/Tools_&_Guidelines_Smallhospitals.pdf

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11) Guidelines for EstablishingSentinelSurveillanceHospitals and Management of Severe Malaria Cases http://www.nvbdcp.gov.in/Doc/SSH_Management_Malaria_update.pdf

12) Operational Manual for Integrated Vector Management in India: http://nvbdcp.gov.in/Doc/IVM10_March_2016.pdf

13) Guidelines for ITNs / LLINs. http://www.nvbdcp.gov.in/Doc/Guidelines-for-ITNS-LLINS.pdf

14) Guidelines for larvivorous fish use. http://www.nvbdcp.gov.in/Doc/Guidelines-larvivorous-fish.pdf

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